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NOTES AND COMMENTS.

Foundry Trade Societies.

At the recent convention of the American foundrymen it was proposed, in order to secure a greater unity of action among the allied organisations, to manage the various societies from one centre, each society, however, retaining its own identity. The plan also included the publication of all the proceedings and contributions in one journal, thereby preserving literature which at present only indiscriminately finds its way into print.

The proposal has much to recommend it, and if the plan is carried out, it will start a new era in foundry advancement. It is becoming more than ever recognised that the systematic publication of the papers read, discussions, and general proceedings of a society is as essential and important as the actual meetings themselves. A paper read before a society is, at the best, presented to a restricted circle, and its influence is accordingly limited, until through the technical press or some similar medium it is placed before the public at large. Even should every person present at a lecture fully appreciate at the time the value of a paper or the discussion (and this is hardly likely), the value is enhanced when it is placed permanently on record for reference. Not many men—perhaps no man—can assimilate immediately all the information offered at a meeting; it is when some difficulty occurs in the shop, and the worker has to refer to the experience of others for help that he appreciates the usefulness of information tendered. Accordingly, if the foundryman is to be assisted he must not only be given the benefits of the society's work, but he must have the proffered information placed at his disposal in such a form that he can readily refer to it when necessary. This has come to be recognised by nearly every society, and proceedings are published usually in hand-book form.

The Small Founder and His Work.

There are distributed throughout the country hundreds of small shops—par-

ticularly engineering shops with foundries attached—that have a few workers who need to keep in touch with all foundry matters. The work dealt with is often very miscellaneous, and the amount of knowledge required for successful working is not often possessed by one man. In such cases reference books are almost essential, and the publication in some handy form of the experience of other workers would often prove very acceptable, particularly as many of these men are not in touch with their trades' associations.

Technical Papers and Societies' Proceedings.

There is a distinct difference between the technical journal publishing reports of meetings, and the whole of the papers and discussions being brought together. The province of a journal is to gather matter of interest to the readers, and present it in acceptable form, with any fair comment on the subjects dealt with. Incidentally the proceedings of a society may be treated, but if such a society is holding frequent meetings where lengthy papers are read, the journal that lays itself out to fully report these must be no small publication; for there are many other matters of importance that require to be brought before the readers. If, however, any journal is deputed to publish verbatim the proceedings of a society, that obviously meets the case.

The range of literature required by the foundryman is extensive, and includes the work of several bodies, such as the brass-founders, iron-founders, moulders, pattern-makers, and foundry foremen. Taking the case of America, these each have their distinct society or association, and treat with their own individual requirements; but there is a large number of the workers that require to know something of each branch. The proposal of the American Associations to unite their efforts in the manner stated would, in such cases, prove very acceptable. Various writers have taken up this question, and endeavoured to present in handbook form information on the foundry generally. These hand-books are undoubtedly very acceptable to the worker, but they essentially deal only briefly with the different subjects. In this they are distinct from the lecture delivered before an association, for the latter usually deals exhaustively with one topic.

The Technical Library.

There is a marked difference in the attitude of employers to-day as compared with a few years ago, respecting the acquisition of knowledge by their employés. No longer is there any restriction placed on the workman, but he is rather encouraged to perfect himself for his work. But there is still room for further energy and thought to be expended by the employers in providing the means for education.

In many German concerns—particularly chemical work—there are installed quite extensive libraries with also the current magazines and journals of the trade, and the employés are encouraged to make use of them for their own advancement. The same idea is carried out to some extent in this country; and, of course, such works as own laboratories must have some stock of reference books. But were the idea taken up more generally mutual benefit would certainly result. The initial cost of installing such a library would perhaps be a big item to small shops, but there are very many shops where the expense would be no serious deterrent. We recommend the scheme to all employers who wish to see their men take an interest in the business.

——o——

NEW BRASS CASTING REGULATIONS.

FOLLOWING with remarkable promptitude upon the publication of the report by Mr. W. Wills, as the result of his inquiry into the draft regulations proposed for brass foundries,* a series of new regulations has been issued by the Home Secretary in an official circular numbered 484 and dated June 20, 1908. The circular reads as follows:—

Whereas the casting of brass or any alloy of copper with zinc has been certified in pursuance of Section 79 of the Factory and Workshop Act to be dangerous, I hereby in pursuance of the powers conferred on me by that Act make the following Regulations and direct that they shall come into force on the 1st day of January, 1910, and shall apply to all factories in which the casting of brass is carried on, with the following exceptions:—

(i.) The Regulations shall not apply to a sand-casting shop having an air-space equivalent to 2,500 cubic feet for each of the persons employed nor to any other casting-shop having an air-space equivalent to 3,500 cubic feet for each of the persons employed.

* See last month's FOUNDRY TRADE JOURNAL.

Provided—(*a*) that provision is made for the egress of the fumes during casting by inlets below and outlets above of adequate size, and (*b*) that a notice in the prescribed form, giving the prescribed particulars, shall be kept affixed at or near the entrance of the casting shop, and that a copy thereof shall be sent to the Inspector of the district, and (*c*) that the conditions of exemption stated in such notice are not departed from.

(ii.) So much of Regulation 1 as requires that exhaust draught shall be maintained during the process of casting shall not apply in the case of strip or solid drawn tube casting or any other class of casting which the Secretary of State may certify on that behalf, provided that—(*a*) the exhaust draught cannot be so maintained without damage to the metal (proof of which shall be upon the occupier); and (*b*) the exhaust draught is put into operation immediately after the casting; and (*c*) provision is made for the egress of fumes during casting by inlets below and outlets above of adequate size.

(iii.) Where it is proved to the satisfaction of the Chief Inspector of Factories that by reason of exceptional features in the construction or situation of a casting shop, or by reason of the infrequency of the casting or the small quantity or the nature or composition of the metal cast, or other circumstances all or any of the Regulations are not necessary for the protection of the persons employed he may by certificate in writing (which he may in his discretion revoke) exempt such casting shop from all or any of the provisions of the same, subject to such conditions as he may by such certificate prescribe.

In these Regulations (including the above provisions and exceptions)—"Brass" means any alloy of copper and zinc. "Casting" includes the pouring and skimming of brass. "Casting shop" means any place in which casting of brass is carried on. "Sand-casting" means casting in moulds prepared by hand in sand or loam or sand and loam. "Sand-casting shop" means a place in which no kind of casting other than sand-casting is carried on. "Pot" includes any crucible, ladle, or other vessel in which the brass is skimmed or from which it is poured. "Employed" means employed in the casting-shop in any capacity. "Persons employed" means the maximum number of persons at any time employed.

It shall be the duty of the occupier to observe Part I. of these Regulations, and the conditions contained in any certificate of exemption. It shall be the duty of all persons employed to observe Part II. of these Regulations.

Part I.

Duties of Occupiers.—(1) Casting of brass shall not be carried on unless the following conditions are complied with :—

(*a*) There shall be an efficient exhaust draught operating by means either of (i.) a tube attached to the pot, or (ii.) a fixed or movable hood over the point where the casting takes place, or (iii.) a fan in the upper part of the casting shop, or (iv.) some other effectual contrivance for the prompt removal of the fumes from the casting shop and preventing their diffusion therein. The exhaust draught shall be applied as near to the point of origin of the fumes as is reasonably practicable, having regard to the requirements of the process, the maintenance of the exhaust draught during the process of casting, and (as regards casting shops in use prior to January 1, 1908) the structure of the premises, and the cost of applying the exhaust draught in that manner.

(*b*) There shall be efficient arrangements to prevent the fumes from entering any other room in the factory in which work is carried on;

(*c*) There shall be free openings to the outside air so placed as not to interfere with the efficiency of the exhaust draught.

(2) There shall be provided and maintained in a cleanly state and in good repair, for the use of all persons employed, a lavatory, under cover, (i.) with a sufficient supply of clean towels, renewed daily, and of soap and nail brushes, and (ii.) with either—

(a) A trough with a smooth, impervious surface, fitted with a waste pipe without plug, and of such length as to allow at least 2 ft. for every five such persons, and having a constant supply of warm water from taps or jets above the trough at intervals of not more than 2 ft.; or

(*b*) At least one lavatory basin for every five such persons, fitted with a waste pipe and plug or placed in a

trough having a waste pipe, and having either a constant supply of hot and cold water, or warm water, laid on, or (if a constant supply of heated water be not reasonably practicable) a constant supply of cold water laid on and a supply of hot water always at hand when required for use by persons employed.

(3) No female shall be allowed to work, in any process whatever, in any casting shop.

Part II.

Duties of Persons Employed.—(4) No person employed shall leave the premises or partake of food without carefully washing the hands.

(5) No persons employed shall carry on the pouring of brass without using apparatus provided in pursuance of Regulation 1 (*a*).

(6) No person employed shall in any way interfere without the knowledge and concurrence of the occupier or manager with the means provided for the removal of fumes.

———

At a meeting of the Council of the Walsall and District Chamber of Commerce, Mr. E. J. Shaw presented a report on the new brass-casting regulations, and said the new rules were much more reasonable than those originally proposed. While the proviso that the new rules should not apply to a casting shop having an air space of 2,500 ft. per man might not be very helpful to manufacturers generally, the regulation requiring the provision of an efficient exhaust draught had been qualified so that some other effectual means for the prompt removal of the fumes might be taken. This really gave manufacturers all they asked for, and, with this alternative conceded, the regulation in this respect must be deemed perfectly fair. As regarded the clause by which manufacturers would be compelled to provide a supply of clean water and other conveniences, including nail-brushes and towels, for their workpeople, he thought manufacturers—while recognising the health of their workpeople was a matter with which they were concerned—were justified in complaining of regulations which cast all the responsibility in these matters on the employer. It was important to note that where only a small quantity of metal was cast the regulations need not necessarily apply, but whether Walsall would come within this section depended entirely upon the view taken by the local factory inspector.

FOUNDRY PLANT AT THE DEUTZ GAS ENGINE WORKS.

E. Neufang ("Stahl und Eisen").

(*Continued from page 325, June.*)

The rapid conveyance of the molten metal—an important point in securing hot pouring—is rendered possible by an extensive system of rail tracks, and a number of high-speed travelling cranes of modern type. The latter include the following electric 3-motor travelling cranes:—One 40-ton crane, three 25-ton cranes, three 15-ton cranes, two 10-ton cranes, three 3-ton cranes operated from below, eleven 2-ton hand-travelling cranes, and five swing cranes worked by hand.

The large casting ladles are conveyed from one room to another on an electric truck of standard gauge, current being supplied through a flexible cable mounted on a reel.

The moulding shop is in several divisions—moulding-machine shop (Fig. 13), small-moulding shop, medium-moulding shop, moulding shop for large castings, and loam-moulding shop. The staff in these shops numbers 460 to 480 hands, under the charge of four foremen. At present there are 32 moulding machines in use, eight of them being special machines. In view of the large number of small castings required, the efficiency of the moulding machines is a matter of importance; and four-fifths of the total number of small gas-engine parts are moulded by machinery, hand-work being only employed for the pieces that are needed in small quantity and cannot be moulded in a machine. The patterns and plates are made in a pattern shop, either in plaster or metal. Nothing but the complicated cylinder heads and small jacketed cylinders are moulded in the medium shop, and the large shop deals with all pieces weighing over half a ton. All these pieces are cast in dried moulds and finished by contract.

The introduction of large gas engines imposed new and difficult tasks on the foundry, especially in the loam-moulding department, in which the large jacketed cylinder moulds are made; and only by the intimate combination of science and practice has it been possible to attain the high tensile strength requisite for the cylinder metal, and to overcome the technical difficulties arising from the unequal contraction entailed by

the construction of these pieces. That these requirements are met by a well-equipped loam-moulding shop (Fig. 14), is proved by the fact that out of about 130 gas cylinders cast in loam moulds, only three turned out useless, on account of shifting cores.

Two large casting pits, measuring 16½ and 10 ft. in diameter, and the same in depth, are contained in this shop. During the last twelve months, compressed air machines have been satisfactorily employed for ramming the loam moulds in these pits; and it is calculated that each machine will do the work of four to five men. Ten of these machines and measured 13 ft. in length, including the waste head. The inner wall was 2 in. thick, the outer jacket 2¾ in.

Above the rammed loam mould is placed a T-iron girder, mounted on supports that are independent of the mould; and two graduated iron rules are mounted on the girder. Two tubes A and B were built into the mould, and each of them was fitted with a round iron bar, free to move, and terminated at the lower end by a welded piece, at right angles to the rod and extending into the mould cavity, so that the one piece united during the casting process, with the inner wall of the cylinder, and the other piece

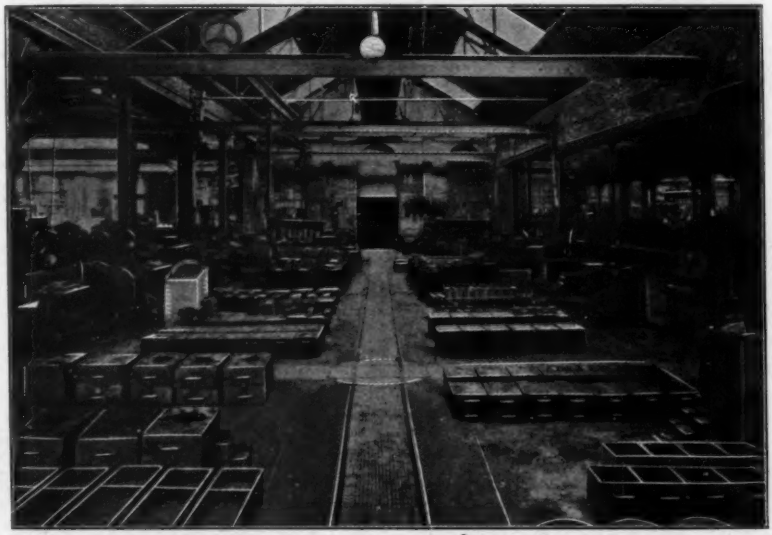

FIG. 13.—VIEW OF NO. 1 MOULDING MACHINE SHOP.

are also used in the sand-moulding shop, and have proved very useful in moulding large pieces; in fact, they are preferred by the moulders.

Owing to the great thickness of the jacketed gas cylinders, it is essential to know the capacity of the iron to resist strains and also to ascertain the ratios of contraction of the metal. To find out, once for all, whether the inner or outer walls of the jacketed cylinders contract first, and at what relative periods the contraction occurs, the following experiments were performed (see Fig. 15). It should be mentioned that the inner core wall was bricked and filled up with sand and coke. The cylinder had a 33-in. bore, with the outer wall. After making the casting, the pointers at the top of the iron rods were set to definite marks on the respective rules, and then observed. Their behaviour showed that the outer cylinder wall began to contract at the end of three hours, whilst the inner wall continued to expand during that time, then remained quiescent for 11 hours, and only began to contract in the twelfth hour, after pouring. At the end of 24 hours the outer wall had shrunk 7 mm., the inner one only 2½ mm.; after 36 hours the ratio was 15.10, and after 80 hours 26.23. The cylinder was cleaned up 94 hours after casting, the inner core being pushed out first, whilst the outer

loam mould was left on until next day. It may be assumed that the inner cylinder wall had shrunk to the same degree as the outer one by the time the metal was perfectly cold.

This experiment lays no claim to perfect accuracy. Whether the rods expanded more or less under the influence of the heat is immaterial; the results show, in any case, that the outer jacket contracts sooner than the inner wall. It may be safely assumed that the inner cylinder remains subjected to a slight tension stress, which, however, will be equalised when the engine is working, since the jacket remains cool. The existence of this tension in the inner cylinder was demonstrated in a test performed by Ehrhardt & Sehmer in a grinding machine. On turning down the inner shell of a spoilt cylinder, the metal broke through suddenly, the crack gaping about one-twelfth of an inch, thus proving the existence of considerable tension in the inner cylinder. This result was borne in mind when making subsequent castings, care being taken to ensure more rapid cooling of the inner cylinder by removing the sand and coke of the core about two hours after pouring, and then leaving the uncovered mould over night in the pit as usual, until fully cooled.

Owing to the special requirements exacted of the iron for the cylinders and cylinder heads of large gas engines and Diesel motors, the above-mentioned continuous chemical tests are supplemented by daily ascertaining the strength of the material in a testing machine of unusual dimensions (Fig. 16).

It being useless to employ test rods of 30 to 40 mm. diameter, in view of the low silicon content (about 1 per cent.) of the metal necessary for castings 2¼ to 2¾ in. thick, these thin rods being white all through, thicker rods were made (60, 80, 100, and 120 mm. diameter) according to the castings in question, in order to obtain information on the grain of the metal, especially for the cylinders. Even in 4 to 5 in. rods (100 to 120 mm.) the grain is somewhat finer than in castings 60 to 70 mm. (2¼ to 2¾ in.) thick, owing to the more rapid cooling. The testing of these thicker rods required a machine capable of giving a load up to 25 tons; and the machine now in use was constructed for tensile and bending strain tests by the Düsseldorf Maschinenbau A.G. For the bending strain tests the machine is fitted with an ingenious device which excludes the impression made on the bar by the die from being recorded as deflection. The load applied at each

FIG. 14.—LOAM MOULDING SHOP.

test is recorded in the gauges by transmission through liquids; and one of the gauges is standardised for checking purposes. An automatic recorder gives a graphical representation of the load and

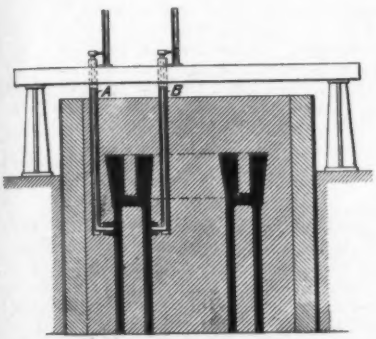

FIG. 15.

flexion in each bending test. A separate flexion indicator, provided with a vernier, enables the flexion to be read off down to 0.1 mm. The machine, which is of very strong construction, is driven by a direct-coupled motor, which can be reversed by means of a controller and suitable switch connections, and switched up to any desired speed, so that the application of the load proceeds in an extremely cautious manner. A test rod of cylinder iron, 80 mm. in diameter, loaded in the centre of a free length of one metre, withstood a pressure of 10,150 kilos. (10 tons), which produced a flexion of 12.5 mm. (½ in.), equivalent to a bending strength of 50 kilos. per square mm. (71,114 lbs. per square inch). This extremely high figure is exceptional, the average of the metal for thick cylinders being 59,700 to 65,400 lbs. per square inch, whilst the strength of the cylinders themselves is naturally somewhat lower, tests on rods made from a spoilt cylinder giving a strength of 56,890 lbs. The composition of the metal referred to was: Total carbon, 3.10 per cent.; combined C. 0.95, Si 0.81, Mn. 0.73, P. 0.20, S. 0.08 per cent. The high bending strength, coupled with the considerable flexion, is explained by the composition. The low total carbon is noteworthy, as being very difficult to obtain in cupola furnaces; whilst the concurrently low percentages of phosphorus and sulphur show the material to be of the very best quality obtainable from this type of furnace.

The percussion tests are performed with the Martin's swing hammer made by F. Becker, of Berlin (Fig. 16), the tests being applied to the fragments from the bending tests. These percussion tests are found to give the clearest indications of the mechanical properties of cast iron, a sample which exhibits a high bending strength, but low flexion invariably having a low power of resistance to percussion and shock; whereas, on the contrary, the percussion strength increases with the

FIG. 16.—TESTING ROOM.

flexion. Unfortunately, the comparison of percussion tests is restricted to rods of the same diameter, the conditions varying with the diameter, so that it is impossible to establish a scale of percussion strengths per unit of sectional area, to form the basis of comparison. Castings exposed to considerable wear and tear are also tested for hardness, by means of a small portable drop tester, the hardness being measured by the length of the incision made by a chisel acted upon by a force that is constant in all the tests. The metal is classified into three grades of hardness.

The ratio of contraction of the various mixtures of iron is tested in a contraction meter, which records the curves for rods 1 metre long and 30 to 60 mm. in diameter. The results obtained by experiments with this meter have been collected in tabular form containing the details shown in the appended table :—

pyrometer. The areas of the pouring gates are carefully calculated in order that the pouring of the metal may be completed within a given time, 50 seconds being allowed for a 6-ton cylinder. All cylinders are cast from the top, gates of special construction being employed.

A highly important position in the works is occupied by the core shop (Fig. 17). The composition of the sand mixtures employed varies according to the ultimate uses of the cores. Small cores for jacketed castings, such as motor car cylinders, cylinder heads, valves, etc., are made of material that will readily fall out of the mould when struck after casting. The cores for all articles to be produced in quantities are made in iron core boxes, with gauges ensuring accuracy. The circular loam cores are turned in lathes differing from those generally used in foundry work. The core spindle runs on bearings composed of

No.	Article.	Weight. Cwt.	Order No.	Client.	Casting. Date.	Grade No.	Composition of Mixture.	Temperature °C.	Time occupied in pouring.	Results of Analysis. Analysis No.	Total C.	Combined C.	Graphite.	Si.	Mn.	P.	S.	Cu.	As.
	200 h.p. Cylinder.						Cwt. Stock No.												
382	Thickness: Inner shell 40 M.M. outer 50"	110	1963	X.X.	22/10/07	26	3.6 114 2 107 1.6 135 1.2 138 1.0 139 0.6 131 10	1290	48 sec.	1820	3.10	0.95	2.15	0.81	0.73	0.20	0.08	—	—

Bending Strength. Test No.	Strength. Lbs. per sq. inch.	Flexion. Rim.	Diameter of rods. M.M.	Percussion Strength. Test No.	Strength. Feet.	Diameter of rods. M.M.	Tensile Strength. Test No.	Strength. Lbs. per sq. inch.	Hardness. Test No.	—	Contraction. Test No.	Per cent.	Remarks.
1232	66,847	12.8	60	1795	320	60	1156	34,100	3765	3	—	—	
1233	71,114	12.5	80	1796	300	60	—	—	—	—	189	1.24	Casting gate area 9½ sq inches.
1234	67,545	8.9	100	1797	391	60	1157	34,200	—	—	—	—	

The temperature of the iron previous to pouring is determined by a Wanner

two rollers, as in the usual counterpoise devices for flywheels, belt pulleys, etc.

Each pair of lathe standards is mounted adjustably on a planed bed, and each lathe is fitted with two supports, enabling the templets to be adjusted both horizontally and vertically. The saving in power for driving the lathes is considerable, one man being able to do the work of three or four in turning cores up to 32 in. in diameter and 13 ft. long. All cores, except the smallest, are produced by piece-work.

The drying stoves for the cores and mould boxes have been kept together as much as possible during the frequent reconstructions of the works, so that into the foundry. The jacketed doors are packed with slag wool in part, and are partly left hollow for the circulation of air; and each door is fitted with a cone for a maximum thermometer. The stove temperature is tested at intervals, to find out the smallest consumption of coke compatible with the highest temperature (average 300 to 350 degrees C.). About 6 to 8 lbs. of second-grade coke are consumed per cubic yard of stove capacity, to produce a temperature of 300 C.

All stoves are fired direct, this having been found the most advantageous

FIG. 17.—VIEW OF SMALL CORE SHOP.

now there are eleven of these stoves in a row. To minimise the diffusion of smoke in the foundry, these stoves are connected with a chimney stack 100 ft. high and 4 ft. wide at the mouth. Eight of the fifteen drying stoves have slotted or detachable covers, to facilitate charging with the travelling crane, the congestion produced by trucks being thus avoided. The detachable covers, K (Fig. 18) are single slabs, the opening in the stove top being reduced to a width of 40 in. by stages on which the covers are laid. Tight joints are obtained by resting the edges of the covers in E-irons fitted with quartz sand. These arrangements prevent the dissemination of smoke method, generator gas firing being impracticable on account of the local conditions. The gases escape through two openings, in the top floor respectively, fitted with dampers which are connected in such a manner that the upper damper is fully open while the stove is being heated up, whereas the bottom one is closed, this enabling the smoke to draw off better. In about an hour and a half, the top damper is closed, and remains so when the bottom one is opened. When the latter is set so as to leave an opening about 2 in. high and 12 in. wide, the gases will draw off freely. The fires can be fed from outside; the grates are only about a foot below the bed of the stoves,

and as the fireplaces are covered with thick cast-iron grid plates, the radiant heat is utilised.

The large pieces moulded in the floor are dried by the aid of portable drying stoves (18 in number), each fitted with a small electric fan. Several sets of pipes, with six to eight branches, are arranged in the floor, the mould boxes being placed over these at night and dried by hot air from the portable stoves. Small cores are dried in a circular stove, heated by gas. The stove is fitted with a vertical revolving shaft carrying a number of perforated circular plates. The temperature in this stove can be raised to 350 degrees C.

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THE PYROMETRIC INSTALLATION IN THE GUN SECTION, ROYAL GUN AND CARRIAGE FACTORIES, WOOLWICH.

By Wesley J. Lambert, F.C.S.

(Chief Metallurgist, Royal Gun Factory, Woolwich.)

Although of the numerous forms of pyrometers now upon the market each may be admirably adapted for temperature measurements under the particular conditions best suited to the instrument itself, it cannot yet be claimed for any one pyrometer that it is a practicable and reliable heat-measuring instrument under all the varying conditions met with in the arts and industries.

The introduction of the system about to be described, though admittedly only including a single type of pyrometer, has for its sole objective the control of the thermal treatment of the steel to be subsequently used in the construction of ordnance. Such thermal treatment for the purpose of this description is held to comprise the heating of the steel for forging operations under the steam hammer or hydraulic press, together with the subsequent annealing, oil-hardening, tempering and shrinkage operations.

Some attempt to control temperatures pyrometrically appears to have been considered in the department nearly fifty years ago. In the year 1862, Bystrom's patented pyrometer, exhibited and awarded a gold medal at the Great Exhibition, was the instrument chosen for the experiments. This pyrometer is still in existence and in an excellent state of preservation. It is a prototype of the well-known Siemens water pyrometer. It consists of a small hexagonal vessel of zinc, 4 in. across the flats neatly lagged with mahogany. Upon the top provision is made for the insertion of a thermometer by a bayonet joint. A circular brass cap protects a funnel, the prolongation of which ends in the interior of the vessel in the shape of a wire cage so placed that it approximates the centre of the chamber. Water is introduced, and a small metallic ball or cylinder was the medium heated; the *modus operandi* being in all respects similar to that in the various well-known forms of water calorimeters.

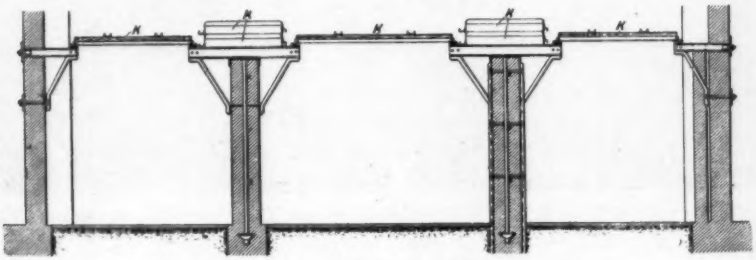


Fig. 18.—Section through the Drying Stoves.

The first mention in the records of the testing laboratory of the systematic use of a pyrometer for the purpose of controlling the thermal treatment of ordnance steel appears in the records for the month of November, 1882.

The pyrometer in those comparatively early days of systematic pyrometry was the older form of Siemens' electrical resistance pyrometer with galvanometer and resistance box, several of which were in use for many years. A battery of these last-named pyrometers with their modifications as introduced from time to time,

including the later pattern direct-reading instruments, the Siemens water pyrometer with heavy platinum cylinder. Murrie's patent pyrometer, Bailey's patent pyrometer (the expansion of a metallic rod), together with several patterns of optical pyrometers, constituted the types of instruments in use throughout the factory previous to the present uniform installation of the thermo-electric couple.

To Colonel Holden, F.R.S., R.A., the present superintendent of the Royal Gun and Carriage Factories, must be accorded the credit of introducing to the department the instrument now in use.

The thin edge of the wedge, which in course of time has dislodged all the other forms of pyrometers in the department in favour of the thermo-couple, was the introduction in 1900 of the simple instrument of the indicating pattern (Fig. 2), supplied by Messrs. James Pitkin & Company, of Clerkenwell, London, E.C.

The rapidity with which the temperature was "picked up" and any fluctuations in the heat bath indicated, at once established its utility and installed it in the favour of those officials in the department interested in high-temperature measurement.

The complete pyrometer consists of—

(*a*) The thermo-junction;

(*b*) An indicating galvanometer.

The thermo-junction simply consists of a more or less lengthy pair of wires of dissimilar metals, one end of each wire being twisted together thus forming a junction which, to all intents and purposes, is regarded as a battery, since such a junction when heated is the seat of an electro-motive force which is a function of the temperature.

The wires forming the hot junction must necessarily withstand fairly high temperatures, seeing that the couple has to be introduced into furnaces, the heat of which sometimes exceeds 2,000 degrees F. A suitable couple consists of a pure platinum wire together with a wire of 10 per cent. iridio-platinum alloy, and thermo-couples of these two metals are

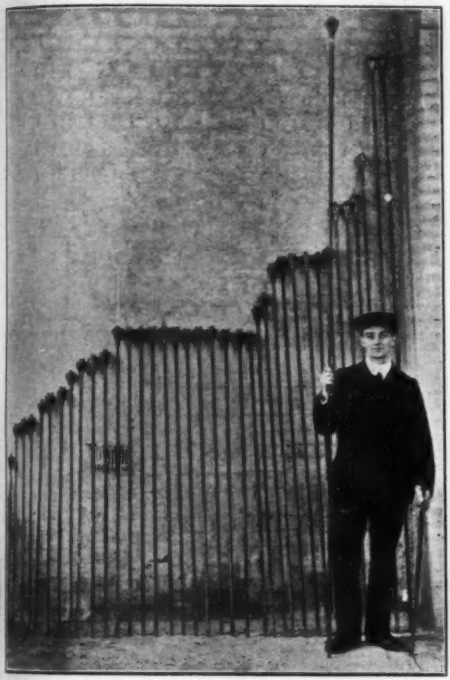


FIG. 1.—A BATCH OF PYROMETERS.

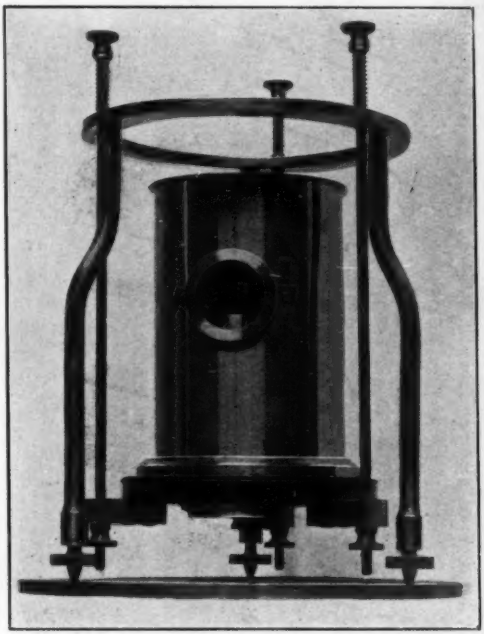


FIG. 4.—GALVANOMETER SUSPENDED IN TRIPOD.

used exclusively throughout the present installation. The free ends of the two wires are available for the copper leads joining up to the indicating galvanometer.

The wires of the couple for furnace work are preferably threaded through double-drilled fireclay tubes which serve

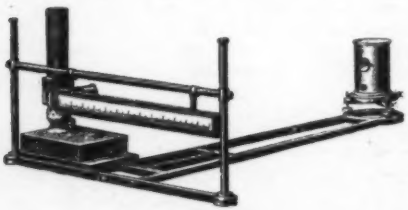


FIG. 2.

to keep them apart throughout their length, and the whole inserted in a covering sheath of gas or steam barrel, the junction end of which is closed by a thin iron disc welded securely into the end. To the open end of the sheathing is fixed a head which serves to carry two terminals, on the underside of which the ends of the wires forming the couple are connected, thus ensuring a clean contact. The copper leads to the galvanometer being attached to the exposed portion of

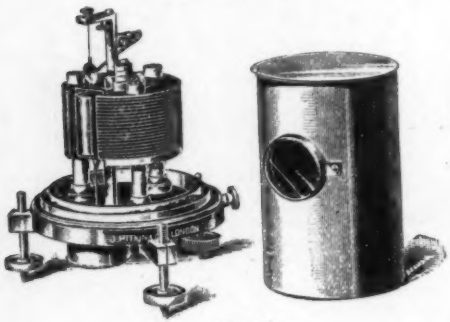


FIG. 3.

the terminals, care is necessary to secure a clean contact whenever connection is made. A further detailed description, together with a sketch of a couple as in use in the present time, is given further on.

The galvanometer is of the reflecting type, and of simple construction. It is a modification, devised by Colonel Holden over twenty years ago, of D'Arsonval's galvanometer, and consists of a built-up, laminated horse-shoe magnet, between the poles of which an adjustable frame holds a circular iron core round which a light silver "former" wound with a coil of

FIG. 5.—RECORDING PYROMETER.

wire partially revolves. This coil is held suspended between the top and bottom of the frame by a fine metallic strip of flattened phosphor-bronze wire. Fixed to the upper portion of the moving coil is a small, circular, silvered mirror, which serves to indicate any movement of the coil, in all respects similar to the well-known principle of reflecting galvanometers.

This form of galvanometer is particularly adapted for this class of work, and is practically dead-beat. Its internal re-

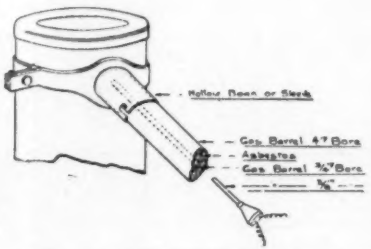


FIG. 7.—PROMETER MUFFLE ARRANGEMENT TO MUZZLE END OF 12-IN. GUN TUBE.

sistance is about 80 ohms. The instrument is enclosed by a cylindrical brass cover having a small glazed aperture in the front, thus exposing the mirror. Fig. 3 shows the details of this galvanometer.

The great advantage gained by the use of the reflecting type of galvanometer for pyrometric work lies in the fact that it is possible to employ a much more ex-

tended reading scale than is practicable with other forms of instruments, owing to the fact that it is much more sensitive. The electromotive force, it must be remembered, cannot be increased. Moreover, the scale being an arbitrary one, and also movable, any readjustment of the zero of the galvanometer is easily accomplished.

The galvanometer, together with a suitable illuminating lamp and transparent centimetre scale, are erected upon a rigid though light frame of cast-iron.

Upon connecting up the couple to the galvanometer through the copper leads, any application of heat to the junction produces an electromotive force, which, in its turn, causes the suspended coil to partially revolve; the mirror at the same time fulfils its function, and the beam of light upon the mirror is thereby reflected to a corresponding position on the scale.

This, then, was the first contribution to the present-day installation, and was reserved for ascertaining the temperature of the lead bath for heating test-specimens.

A second instrument was ordered for use at the big furnaces of the oil-hardening and annealing section. Here, on account of the close proximity of the heavy hammers and other ponderous machinery, some difficulty was experienced on the scale of vibration, even though the instrument was placed on a solid pedestal of concrete, the footings of which were several feet below the ground level.

Closely following this second instrument, a further addition was introduced, an instrument of the recording pattern, also made by the same firm (Messrs. James Pitkin & Company), to the specification of the instrument used by the late Sir W. Roberts-Austen, and designed for his work at the Mint by Colonel Holden. This instrument, necessitating some slight knowledge of photography, the record being a photographic one, was handed over to the metallurgical laboratory.

With this instrument also some slight trouble was experienced through vibration; but this, after a few experiments, was successfully overcome by suspending the galvanometer from a tripod in such a manner that the vibration was absorbed by three small spiral springs so arranged as to be in partial compression (see Fig. 4). This method of suspension has proved an admirable one, and has been adopted throughout the system.

Several interesting thermo-metallurgical observations having been made concurrently with the calibration experiments upon this instrument, it was finally decided that it should be permanently retained in the metallurgical laboratory as a standard instrument available for comparison, and for such experimental work

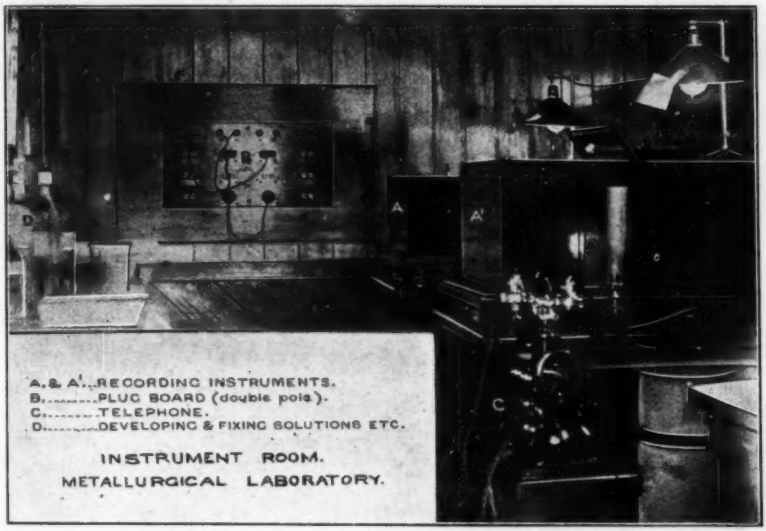


FIG. 6.

as might arise, and that the oil-hardening section should be wired up to the laboratory in order that photographic records of thermal treatment in the mass might be obtained for permanent record as occasion might demand.

These three instruments formed the nucleus of what is now regarded by experts as one of the most complete pyrometric installations in the kingdom.

Fig. 5 conveys an idea of the external appearance of the recording pyrometer, and it may be well described as consisting of two light-tight mahogany cases, the larger of which (A) contains a "Holden-d'Arsonval" dead-beat galvanometer similar to that used with the indicating instrument, with a suitable arrangement of lenses, mirrors, etc. The other case (B) contains a drum which is made to revolve by contained clockwork. The surface of this drum is covered with sensitised photographic paper. A ray of light, from either a gas jet, or a lamp, is thrown by means of a mirror, at an angle of 45 degrees, on to the mirror of the galvanometer, and is projected thence to the surface of the drum, and acts photographically on the sensitised paper. The galvanometer is then connected by copper leads to a thermo-junction inserted in the place the temperature of which it is wished to record.

The heating of the thermo-junction causes a very small current to pass through the coil of the galvanometer which is deflected, and the mirror attached to it projects a spot of light on the surface of the drum.

The amplitude of this deflection indicates the temperature, and a continuous curve is traced on the photographic paper, which at once indicates what temperature had been attained at any particular period. A scale is also provided on which the temperatures can be read from time to time without interfering in any way with the record.

Two recording instruments of this type are in constant use day and night, and constitute the laboratory end of the system. These two recorders are also regarded as the standard instruments of the department. They are mounted on simple iron pedestals, the galvanometers being suspended inside the cameras from their respective tripods.

Fig. 6 is reproduced from a photograph of the instrument room attached to the metallurgical laboratory, and shows the

Furnaces included in Pyrometric System.

Section.	Description of Furnace.	No. of Furnaces.	Type of Furnace.	Firing.
	LARGE FURNACES FOR GUN FORGINGS, &C.			
Oil-hardening and annealing.	Circular tube furnaces.	4	Open furnace.	Producer gas.
,,	Circular jacket furnace.	2	,,	,,
,,	Circular annealing furnace.	5	Muffle.	,,
,,	Rectangular annealing furnace.	1	,,	,,
,,	Rectangular heating furnaces.	3	Semi-muffle.	,,
,,	Rectangular heating furnaces.	3	,,	Coal firing.
	SMALL FURNACES FOR GUN FITTINGS, &C.			
,,	American rectangular furnaces.	3	,,	Illuminating gas.
,,	American rectangular furnaces.	1	Muffle.	,,
,,	Cyanide hardening bath.	1	Externally heated.	,,
,,	Oil heating baths.	2	,,	,,
	FOR SHRINKING HEATS.			
,,	Coales.	4	—	Producer gas.
Heavy forges.	Large reheating furnaces.	7	Reverberatory.	Coal firing.
,,	Smaller reheating furnaces.	3	,,	,,
,,	Larger heating furnaces.	3	,,	Producer gas.
Drop-forging plant.	Reheating furnaces.	7	Open furnace.	Coke fired.
,,	Fletcher furnaces.	2	Muffle.	Illuminating gas.
Specimen treatment plant.	Lead baths.	2	Externally heated.	,,
,,	American rectangular furnaces.	2	Semi-muffle.	,,
,,	Fletcher furnaces.	2	Muffle.	,,
Toolsmiths.	American rectangular furnaces.	2	Semi-muffle.	,,
,,	Fletcher furnace.	1	Muffle.	,,

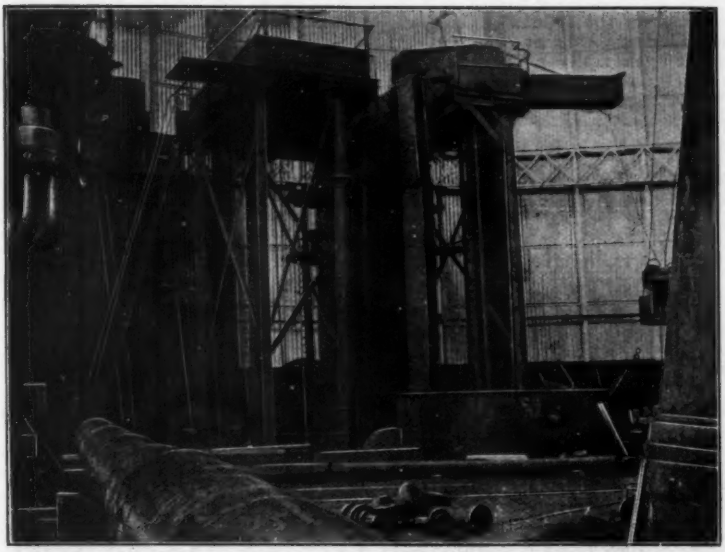


FIG. 8.—VERTICAL FURNACE IN OIL-HARDENING SECTION.

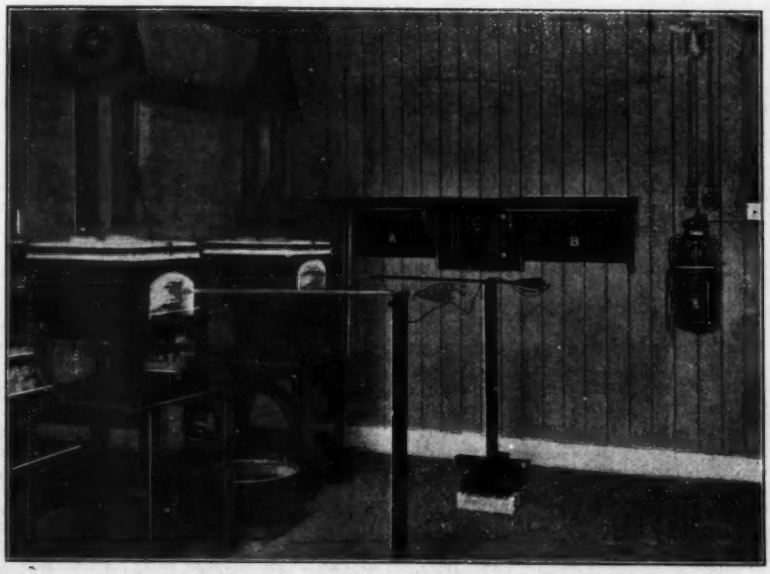


FIG. 9.—SMALL GAS MUFFLES FOR ANNEALING, ETC.

recording pyrometers forming the laboratory portion of the system.

The following branches are now wired up to, and are under pyrometric control from the metallurgical laboratory—the heavy forges, the oil-hardening and tempering branches, the case-hardening shop, the drop-forging plant, the lead bath (specimen treatment plant), and the gas muffles throughout the department used by the tool-smiths and other craftsmen (Fig. 9).

The table on page 456 gives the description and number of the furnaces of each class at present included in the entire system.

(To be continued.)

——o——

THE BAILLOT REGENERATIVE CUPOLA.

In the ordinary cupola, the fuel consumed is utilised in a very imperfect manner, as was formerly the case with the blast furnace before the waste gases were collected and their heat recovered. Of course, the problem is more difficult in the case of the cupola, owing to its smaller size, comparatively simple construction, and the fact that the working is frequently intermittent. These conditions prevent the use of complicated and expensive forms of regenerator; and, moreover, the latter must be of an easily regulated kind, and must not cause interference with the working of the cupola, for instance, by setting up back pressure.

Apart from the waste of fuel due to intermittent working, the imperfect utilisation of the calorific power in the cupola is due to the loss of heat carried away by the waste gases and to the incomplete combustion of the coke, owing to the reduction to carbon-monoxide in the upper part of the cupola, of the carbon dioxide formed in the zone nearest the tuyeres. Since 1 lb. of coke with 10 per cent. of ash will furnish about 3,300 calories when completely oxidised to carbon dioxide, but yields only 1,000 calories when converted into carbon-monoxide, about three times the quantity of fuel is required in the latter circumstances, to produce the same amount of heat in the furnace. This is the reason why the chief attempts at improving the cupola have been directed towards the burning of the carbon-monoxide produced.

The cupola operates under less favourable conditions than the blast furnace, by reason of the cold blast employed, which makes it more difficult to attain the high temperature requisite for the production of a highly fluid metal and slag that will separate readily.

In the Baillot regenerative cupola (Fig. 1), the losses of heat have been reduced to a minimum by the following arrangements:—A portion of the gases discharged from the throat of the cupola is mixed with the blast air forced in through the tuyeres *b* (Fig. 2); and as these gases still contain carbon-monoxide—though the amount has been reduced by the means described later on—they

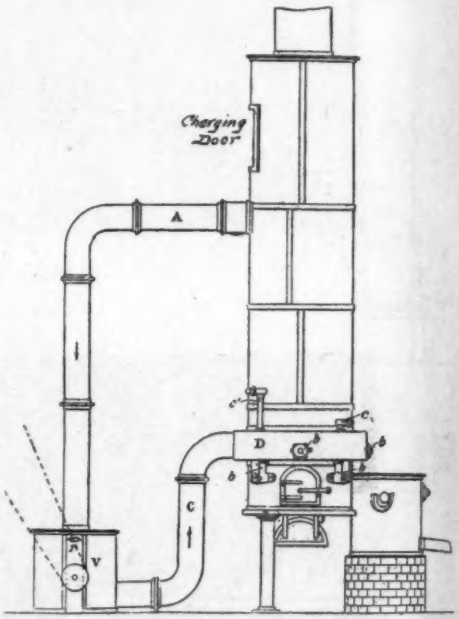


FIG. 1.—ELEVATION OF BAILLOT CUPOLA FURNACE.

possess a certain calorific value, which is utilised, and, moreover, are at a high temperature, which they impart to the blast.

At the points, *h*, where the gases are drawn off, a circular chamber is built into the brickwork, and is provided with apertures, *d*, through which a certain amount of air enters and mingles with the gases, being at the same time heated in its passage through the chamber. The hot mixture is drawn off by a fan, V, through the pipe, A, and in passing through the

fan is mixed with sufficient air to form the blast, this supplementary air entering through the register, *r*. The still hot mixture is delivered into the collector, D, through the return pipe, C. The uniformity of the mixture is secured by the aid of baffles, *k*, composed of suitably shaped castings, R (Figs. 4, 5, and 6), which at the same time equalise the temperature and prevent back pressure.

The analysis of the gases in A, previous to the admission of the supplementary air, shows them to contain, on the average 8 per cent. of carbon-dioxide, 11.5 per cent. of oxygen, and 2.5 per cent. of carbon-monoxide; and a simple calculation demonstrates that this carbon-monoxide furnishes sufficient heat during combustion to economise 12 per cent. of the fuel consumed in a cupola with a capacity of a ton of metal per hour, apart from the heat resulting from the actual temperature of the gases.

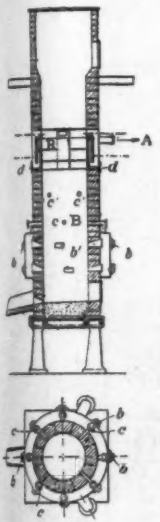
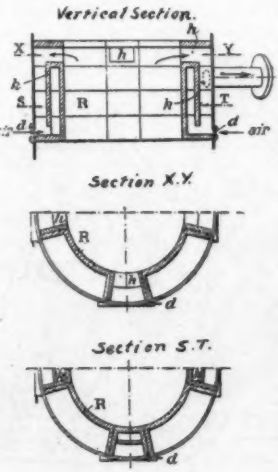


FIG. 2.—VERTICAL AND CROSS SECTIONS.



FIGS. 4, 5 & 6.—SECTIONS THROUGH THE FURNACES AT THE GAS OUTLET.

To enable the maximum quantity of carbon-monoxide to be burned off without spoiling the effect of the other arrangements, two rows of alternating supplementary tuyeres, *c* and c^1, are provided above the tuyeres, *b*, and the air supplied by these extra tuyeres burns off a portion of the carbon-monoxide in that zone of the cupola, the resulting temperature being, however, too low to heat the overlying coke to incandescence. The realisation of this condition forms the chief difficulty in selecting the position of the auxiliary tuyeres. These latter are supplied with air by the fan, through pipes branching from the collector, D, an arrangement which prevents the formation of fresh quantities of carbon-monoxide. Should the high temperature zone show any tendency to extend to an upward direction, the upper row of tuyeres can be put out of action. The principal advantage of the auxiliary tuyeres is most clearly apparent in starting the cupola, when the amount of carbon-monoxide produced is extremely large; and the effects are manifested by a considerable reduction in the consumption of coke at that stage. A further result is the extension of the zone of combustion, the metal being heated up so as to facilitate its melting when it reaches the zone of fusion below. The melting is further accelerated by the hot blast, which gives a higher temperature than usual in the zone of the lower tuyeres, and consequently the molten metal falls into the cupola in a hotter and more fluid state than in the ordinary type of cupola furnace, so that the metal separates more readily from the slag and is in better condition for pouring.

The admission of air through the apertures, *d*, the register, *r*, and the tuyeres themselves, is under perfect control, and the working of the tuyeres can be supervised through peepholes, *b*, placed in front of each. The increased temperature of the zone of fusion diminishes the risk of obstruction of the tuyere nozzles.

In addition to the advantages already mentioned, the cost of production is cheapened by the absence of defective castings ensured by this system, the quality of the resulting metal being higher by reason of the greater fluidity, complete uniformity of the castings, increased strength and easy working by the ordinary tools, whilst the absence of flame issuing from the throat of the furnace lessens the risk of fire.

A number of these cupolas are already in use in many of the large ironworks in France and Belgium; and the makers offer to convert any ordinary cupola free of charge (except for bricks and labourer's wages), in return for a percentage on the value of fuel saved during a covenanted period. Cupolas that are too far gone to stand conversion will be replaced for the cost of the casing.

FOUNDRY BLOWERS.

In the average foundry, power is required for but a short time in the afternoon to operate the blower. When once a heat has been started the supply of air must be kept up until the heat is off. This requires a source of power which is absolutely reliable. As the demand is very heavy at this time, and but small all the remaining time, as low an investment cost as possible is desirable.

For these reasons electric motors are being adopted by foundrymen as the most satisfactory power, especially where current may be purchased from a central station. Electric drive by power that is thus supplied shows many marked advantages over other methods.

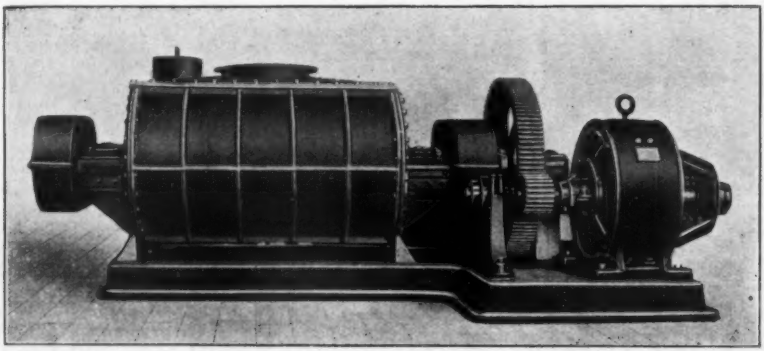
The illustration shows a blower driven by an electric motor suitable for foundry work. The blower is manufactured by the P. H. & F. M. Roots Company, and the motor by the Westinghouse Electric and Manufacturing Company. The sturdy appearance of this outfit is readily observed, and the reliability under hard service will be found to fulfil the promise made by the appearance. The use of adjustable, self-oiling bearings is a particularly satisfactory feature of these blowers.

The blowers are designed for a range of speed variation of approximately 1½ to 1, to allow a variation in the melt to be made if at any time such becomes necessary. For this purpose direct-current motors are frequently used, as they permit the desired changes in speed.

In many installations it is not necessary to be able to adjust the speed of the blower, so that the constant speed characteristics of the induction motor permit its use where alternating current is available.

The approved method of driving is by gearing direct from the motor, permitting the use of a moderate speed motor, thus reducing the original cost, and at the same time doing away with belt drive, which is not entirely satisfactory.

The selection of the size of the motor depends upon the conditions to be met in the foundry. In general a pressure of 16 ozs. may be considered as a fair value for the blower to meet. As the capacity required in the motor is approximately 5 h.p. for every 1,000 cubic feet of air required per minute at 16 ozs. pressure, the required size of the motor is readily determined, when the capacity of the cupola is known. An allowance of 30,000 to 33,000 cubic feet of air is usually made to melt 1 ton of iron.



AN ELECTRICALLY DRIVEN FOUNDRY BLOWER.

As the pressure may increase slightly above 16 ozs. toward the end of the heat, the power required also increases. But the overload capacity of the motor is able to take care of this increase. If the pressure is to be materially different from 1 lb. for any long continued period, the motor capacity should be determined with this in mind. The power will increase or decrease in direct proportion to the increase or decrease in pressure.

The purchasing of power from a central station is attractive to the average foundry. The central station can actually sell the power cheaper than the foundry can make it, since the central station can use its machines for supplying power all through the day, and, therefore, does not receive all its investment returns in a few hours, as the foundryman would have to do if he invested in an electrical plant.

THE METALLURGY OF THE BRONZE AGE.*

By W. M. Corse.

The progress of civilisation, metallurgically, divides itself into three periods. These three sub-divisions are commonly called the stone, bronze and iron ages, and each shades into the other as do the colours of the rainbow. As the province of this paper is the bronze age, only reference will be made to the others. It is true, however, that mention is made of both bronze and copper in the literature relating to the stone age.

Copper.

Some relics point to the existence of a copper age in which the use of tin as an alloy in copper was unknown. In some parts of the world it was some time before the alloying of tin with copper to make it parts of the world it was some time before elasticity and hardness, was known. In Europe only a faint trace of a copper age is to be found, but in North America the Indians took the native copper and fashioned it into weapons and utensils long before the bronze age in Europe.

Practically all of the copper relics found are wrought, not cast. The art of casting appears to have been unknown, although the fact that the Indians knew that copper would melt is mentioned by De Champlain, the founder of the city of Quebec, in 1610.

Tin.

Tin also attracted early notice on account of the great heaviness of its ores. When metals were scarce it would sometimes happen, naturally, that some tin would be added to copper, or *vice versâ*, and it would then be found that the properties of the alloy were quite different from the original metal. No relics of tin have been found alone and very few of copper. The few exceptions possibly indicate temporary lack of either metal.

The Constituents of Bronze.

Bronze, as already stated, is an alloy of copper and tin, and therefore distinct from brass, which is an alloy of copper and zinc. Many varieties of bronze, or as it is now more commonly called, gun-metal, are in use at the present day; and one remarkable feature of bronze is that the admixture with copper of the much softer metal, tin, in varying proportions, produces an alloy in most, if not all, cases, harder than the original copper. When the tin is in high percentage, as in the metal used in the speculæ of telescopes, the resulting alloy is so much harder, that, *a priori*, such a result of the mixture of two soft metals would have been thought impossible. The addition of tin, while increasing the hardness of copper, also renders it more fusible. In small proportions it but little affects the colour of copper, and it is difficult to recognise its presence by the physical characteristics of the copper except from that of increased hardness. It is on this account that many articles of so-called tempered copper have deceived investigators.

Both ancient and modern practice indicate that the most serviceable bronze is a mixture of nine parts of copper with one part of tin, which composition produces a hard though not brittle alloy. Variation from this formula may be due to several causes, some of which are as follows:—

1. Temporary lack of one or the other constituent metal.

2. Separation of tin, called liquation, in the lower part of the casting, causing what are commonly known as tin spots.

3. The loss of tin through oxidation in repeated remelting.

The evidence available makes it most probable that the knowledge of metal is one of the great discoveries which Europe owes to the East, and places the original source of bronze, like that of the Aryan family, in an Asiatic rather than a European centre. This explains why in all countries of Europe where bronze relics have been found, their composition is as nearly identical as the imperfect metallurgy would permit.

Definition of Bronzes.

It may be well to consider the definition of the various bronzes as an aid to a better understanding of what follows. A true bronze is composed of copper and tin in which any other metals present have been introduced by accident, as for instance, through impure copper. True bronzes are the oldest of the several types. True lead bronzes, that is, those in which the lead was introduced advisedly, generally contain very little iron or other accidental metals. In some cases the lead ran over 20 per cent. It is difficult to tell whether a sample of bronze had lead added intentionally or not, on account of the fact that some crude copper of this period has been found containing 20 per cent. of lead. Lead bronzes belong to the Mediterranean countries, and are

* Abstract of a Paper presented at the annual meeting of the American Brass Founders' Association.

especially characteristic of Egypt, Republican Rome and Etruria. Zinc bronzes are later than lead bronzes, and appear to be entirely of Roman origin. Brass was made in Europe as early as the third century, B.C., by adding Smithsonite,* or flue sublimate from furnaces in which ores containing zinc were smelted, to melted copper, with a view of giving the latter a yellow colour. It was, however, about the time of Cæsar that the use of brass became general.

Early Practice.

Professor Sullivant arrives at the following among other conclusions, from the chemical facts at his command:—

1. The northern nations in ancient times used only true bronzes of greater or less purity, according to the kind of ores used.

2. Many of those bronzes contain small quantities of lead, zinc, nickel, iron, and silver, derived from the copper from which the bronze was made.

3. Though some bronzes may have been produced directly by melting a mixture of copper and tin ores, the usual mode of making them was by treating fused crude copper with tin stone. In later times bronze was made by mixing the two metals together.

4. Bronzes were not formed of variable proportions of copper. The makers aimed at the production of definite alloys by mixing the ingredients according to empiric formulæ. There were four types of true bronzes, according to the relative proportions of tin and copper.

The predominant alloy used by all the Northern nations of Europe was gun-metal, containing from 9 to 12 per cent. of tin, the typical alloy being composed of 11 per cent. of tin and 89 per cent. of copper.

5. The great variation in composition of many bronzes which has led to the belief that the ancient bronzesmiths did not aim at the production of alloys of a definite composition, that is, mixed the ingredients in an arbitrary manner, arises from the remelting of the original bronze by which a portion of the tin was oxidised out each time the metal was melted.

6. Copper appears to have been always made from sulphurets, including such complex minerals as grey copper. This implies a considerable amount of progress in mining and metallurgy.

7. The tin ore used was chiefly stream tin, and was obtained in at least four districts of Europe—Cornwall, the Erzgebirge of Saxony and Bohemia, the present Vaulry in France, and Western Austrias and Galacia, in Spain.

8. The copper of the ancient bronzes seems to have been smelted in many different localities.

9. There is no evidence of the existence in Europe of what is called a "copper age." There is every reason to believe that the Aryans knew how to make bronze before their advent into Europe.

10. The bronzes of the early Greeks were true bronzes; those of the Egyptians and early Romans were lead bronzes, that is, contained lead as a normal constituent. The Romans appear to have learned the use of lead from the Etruscans, probably a semitic people.

11. We have no analyses of Phœnician bronzes to enable us to positively assert that they were lead bronzes; but as the Phœnicians received all their civilisation, letters and arts from Egypt, and had continual intercourse with that country, it is scarcely probable that the cheaper and more fusible lead bronzes should be unknown to them, especially as a kindred people, the Etruscans, knew the use of lead.

12. The general use of lead bronzes in the Mediterranean countries, from at least 500 B.C., except in Greece, which appears to have got its tin from Central Asia, renders it highly improbable that the nations of Northern Europe received, at least to any great extent, their bronze arms, tools, etc., from the South of Europe. The presence of lead in some bronze musical instruments and ornaments points to the Southern origin of those articles, at least Southern influence in their manufacture and consequently in their use.

13. Towards the end of the Roman Republic, zinc bronzes came into use in Rome, and are to be found in all the places occupied by them in Gaul, Britain, and Germany. The pure bronzes of Northern Europe are not, therefore, of Roman origin.

14. The bronze weapons and tools found in the Baltic provinces are very rich in zinc, a fact which Professor Göbel thinks, proves that the material at least is of Roman origin. The copper which was used by the bronze founders of olden times, appears to have been smelted from the ore and run in a shallow, concave mould open at the top, in which the metal assumed the form of a circular cake, convex below and flat above, but

* The carbonate and silicate of zinc were formerly called calamine, but that name is now confined to the silicate, the carbonate being called Smithsonite.

before becoming sufficiently cold to be quite set into tough metal, these cakes seem, as a rule, to have been disturbed and broken up into numerous pieces better adapted for remelting than the whole cakes would have been. As to the method of melting the metal but little is known. It seems probable, however, that the crucibles employed must have been vessels of burnt clay provided with handles for moving them; while for pouring out the metal small ladles of earthenware may have been used. In Switzerland, small crucibles of ladle-like form have been found, in some cases with lumps of bronze still in them.

Early Methods of Casting.

The methods of casting may be classed as follows:—

1. In a single mould formed of loam, sand, stone, or metal, the upper surface of the casting showed the flat surface of the molten metal which was left open to the air. The pattern of the model was, in the case of sand or loam castings, pressed into the mould, as described later.

2. In a double mould, either of stone or metal, which must of necessity be in pieces or halves, and show the junction line on the casting.

3. In a double mould of fine sand, by first making a model of the object in wood or some other hard substance and pressing it on the fine sand so as to obtain a corresponding hollow. This method would show the junction line, the same as the previous one.

4. In a solid or wax mould. In this case, as in the former, a wax or wax-coated model was made and enclosed in prepared earth made of clayish soil mixed probably with cow-dung or some other inflammable substance in order that when subjected to heat it might become porous. The mould was then warmed and the wax ran out of the hole through which the metal was to be poured in. This was the commonest method used during the bronze age. It required fewer instruments, and did not, like methods 2 and 3, show a line of junction, which was a great advantage, because in the absence of steel the projecting ridge thus produced was very difficult to remove, especially when the objects were ornamented.

Cores seem to have been used in some castings, and appear to have been made of sand and clay, or in a few cases of metal. Relics have been found with clay cores in them, burned almost as hard as a brick.

The process of casting bronze instruments in loam, clay, or sand, must have been much the same as that in use at the present day; but it was rarely that the mould consisted of more or less than two pieces.

It is not uncommon to find castings which show that the two halves of the mould, or of the flask, had slipped sideways, so that they were not in the proper position when the casting was made. Anyone familiar with the moulding machine practice of to-day must see from the above statement a great similarity between the moulding practice of ancient and modern times. It certainly verifies the statement that the foundry yet furnishes plenty of opportunity for the chemical engineer.

—o—

SPECIFICATIONS FOR CAST IRON TO BE MACHINED.*

By H. E. Diller.

The machine shop which buys its castings generally takes what it gets—soft, medium, or hard—and usually has no redress, except the satisfaction of constant complaint and frequent change of manufacturer. General complaint seems to be the only remedy the machine shop which purchases its castings, feels willing or able to attempt. Although many companies specify that out of each heat one or more test bars shall be cast and tested, this is usually done to insure strength, but not softness, in the iron. There are many castings on which considerable machine work is done, and for which the strength of any soft iron is sufficient. For this class of castings, I would propose a specification which need cover only two points as to physical qualities, and two points in the composition of the iron, and still insure a satisfactory casting.

First, that the castings be free from blow and shrink holes. This is the only qualification the majority of castings require to insure sufficient strength. Second, that the surface of the casting be smooth and reasonably free from sand. Then the two specifications which I would suggest for the composition of the iron, are upper limits for the amount of combined carbon and the amount of sulphur.

It would also be advisable to have a

* Abstract of a Paper presented at the annual meeting of the American Foundrymen's Association.

standard method for determining the amount of combined carbon. By using the colour method and having the same standard, there is no reason why there should be any dispute as to whether the castings were coming up to requirements.

With such specifications, the foundry could be made to stand the extra expense of machining hard iron, and the foundry

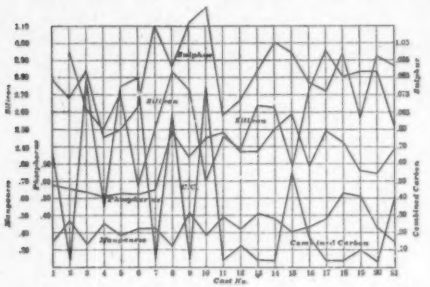


CHART NO. 1.

which could make regularly soft castings could command a higher price for them.

As to the reliability of the combined carbon as an indicator of the hardness of iron, I was convinced by nearly a year of daily tests on a drill press and colour carbon tests. These tests usually agreed closely.

It might be advisable to put an upper limit on the amount of phosphorus, but this limit would be so high as to be practically no limit—say 1 per cent.

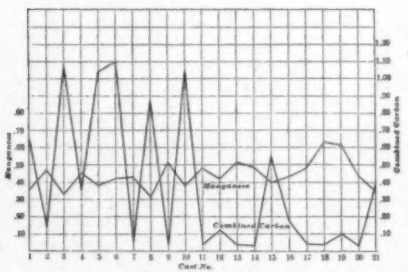


CHART NO. 2.

There are so many variables entering into the making and composition of a casting that to me it seems the only simple way of specifying the quality of the iron for machining is to require it to be free from physical defects and to set a limit on the amount of combined carbon it may contain.

The Effect of Manganese.

The accompanying charts give a graphic illustration of the effect of manganese at the critical point on a fairly high silicon iron, cast in a heavy section to avoid the effects of the mould on the cooling of the iron.

Chart No. 2 gives only the manganese and carbon curves.

On Chart No. 1 we see for the eighth cast, with the silicon nearly the highest of any cast (2.83 per cent.), and the sulphur medium (0.091 per cent.), the combined carbon was high (0.86 per cent.), while in the second cast, in which the silicon and sulphur are about the same as in the eighth cast (2.94 per cent. and 0.073 per cent.), the combined carbon is only 0.04 per cent. Again, taking the ninth cast with sulphur much higher (0.117 per cent.), and silicon a little lower (2.73 per cent.), which should make a harder iron than that in the eighth cast, we find only 0.04 per cent. of carbon. In the hard iron the manganese is 0.32 per cent., while in the soft iron it is 0.47 per cent., and 0.51 per cent. respectively.

From this chart it would seem clear that silicon and sulphur contents will by no means guarantee a soft casting, even in a heavy section, if other conditions are not right, but that a determination of the combined carbon will tell very quickly if the iron is hard.

FOUNDRY CUPOLA AND IRON MIXTURES.

THE proceedings of the American Society of Mechanical Engineers give the following contributed discussions on Mr. W. J. Keep's paper on the above subject.

Mr. E. H. Foster refers to the description of a cupola liner which was patented in the United States.

"While visiting a foundry in London," he says, "where the liner was developed, the owner took me up to the charging floor of a cupola which was being cleaned, and asked me to guess the material forming the lining. On looking down through the charging door the internal surface of the cupola was perfectly clean, free from any projections, of a greyish-white colour, and divided off into squares resembling tile. It was difficult to tell just what the material of the lining was. It resembled somewhat an enamelled tile in appearance, and was much too clean and unbroken to be fireclay."

"As a matter of fact the lining was made of cast iron, built up in hollow blocks of radial brick form. It was claimed that it had been in use for 19 months, and that the cupola, which was a No. 5 Stewart Rapid, was formerly rated at four tons per hour, but that after lining with the cast-iron hollow bricks five tons per hour were easily obtained out of it."

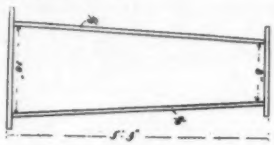


FIG. 1.

"Besides increase of capacity there was a saving in time for repairs, also in the use of ganister. The perfectly smooth surface, prevents all tendency to hang-up, and after each run the surface can be swept clean. Furthermore, there is no danger of such a lining becoming broken by the charging process. It seems that such a lining can be easily applied to almost any type of cupola. Several cupolas in England are so lined, but I do not know of any in this country."

Professor W. W. Bird, says, "Many questions are asked in regard to the use of scrap in foundry mixtures. One point that has not been brought out is this:—We understand that silicon is

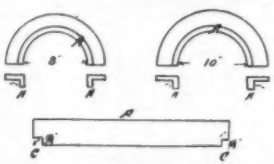


FIG. 2.

used in foundry mixtures for the purpose of making castings soft for machining. In the paper it is stated that it is best to select the scrap according to the thickness of the castings to be made. In selecting scrap it is a very simple matter to specify that the material should give some evidence of having been machined, and that, if this evidence is present, then the percentage of silicon must be somewhere near the proper amount for that thickness. This test should be included in the specifications. Then we will have something that will correspond to the chemical analysis."

A FEW HINTS ON PIPE MOULDING.

By "MOULDER."

IN almost every foundry, jobbing, or otherwise, there are at times, pipes of various shapes and sizes to be made; so these hints may be useful to a number of readers.

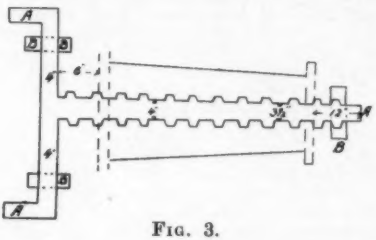


FIG. 3.

In the case of a taper pipe, as in Fig. 1, to make a pattern would require time and money, so instead of a pattern could be used a template, 1 in. thick, two flanges, and strickle (Fig. 2). The procedure would be as follows:—Dig a hole in foundry floor the required length and depth, put in some loose sand and bed in flanges to template, leaving template on top; ram up to the top of template. Square the flanges over the end of template; then, after marking with a trowel along the edge of template, lift off and strickle

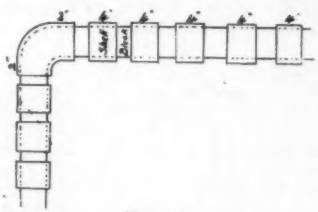


FIG. 4.

out, with the straight side of strickle A (Fig. 2). This gives the inside size of the pipe, or core size. We now proceed to make core; first, having made core iron (Fig. 3), the two pieces marked A A being for lifting and steadying purposes. Put three pieces of flat plate under the core iron B, B, B, Fig. 3, to carry the core; clay-wash the core iron and put about 1½ in. of fine sand in the bottom. Then bed in core iron and ram up bottom half of core. Put on top halves of flange, and put in vent rope about 1¼ in. to 2 in. diameter,

and ram up top half of core. Strickle off top, straight side of strickle B, working on projections A, A, Fig. 2. This gives the outside of the pipe, and we are ready for the top part. Ram up the top part in the usual way, draw vent rope part of top box, and strickle off top of core with C, C, of stickle, working on A, A, of flanges; this gives us the core complete, A, A, Fig. 2. Finish in the usual manner, put in core, and scotch down core iron

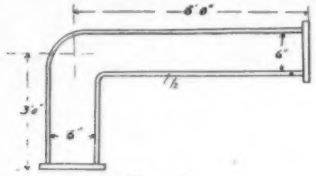


Fig. 5.

Lift out core and strickle out bottom part in the same manner, C, C, working on at A, A, A, Fig. 3. thus doing without a chaplet. If a chaplet be desired through length of pipe, make up a piece or pieces, of iron in centre of core, and ram up chaplet in top part. This method is for green sand, dry sand, or loam, but pipes up to 30 in. in diameter have been made in this way, core skin dried. In all cases jets must be kept as low as possible, so as to avoid striking the core.

Bends, Tees, Cross, and S Pipes.

For the smaller sizes of bends (made in green sand) we require what is known as

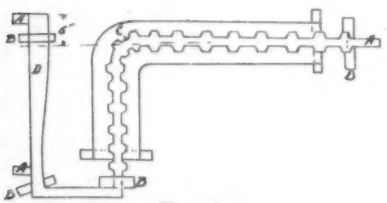


Fig. 6.

shell rings and elbow pieces. The rings are about 3 in. or 4 in. broad, and the required diameter and thickness. Elbow pieces should have 2 in. of straight at each end, as shown in Fig. 4. These patterns are usually made first in plaster of Paris, with double contraction, in this manner. Stickle on a flat board what is known as a block; that is, the internal diameter of the pipe required, and just looks like half of a bend core. Apply one coat of linseed oil and strickle on the thickness of metal required. Allow to dry, and then saw into pieces (Fig. 4). It will be found that the pattern will have expanded away from the block, but in ramming, the bottom of box will go back to the block again. Turn over and lift out block, ram up top part, and finish in the usual way. This gives half of the pattern; the other half, being made in the same manner, we have patterns for al-

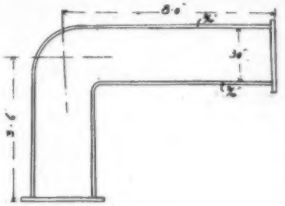


Fig. 7.

most any shape of pipe, which will last for years. I have used shells sixty years old, which were still good. In the event of 60 or 100 duplicates of a pipe being ordered, it is advisable to make a complete shell pattern, and if it is not required again it can be cut up and go to increase the stock of shell rings.

If a pipe, as in Fig. 5, is required, we get a template, as in the case of a taper pipe, Fig. 1, and flanges. Dig a hole, put in fine sand and arrange shell rings to template, leaving 4 in. or 5 in. between each. Ram up to top of template, lift off template, and take care that none of the

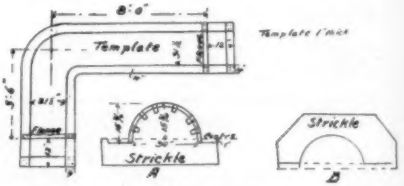


Fig. 8.

rings have been rammed out of place. Next, make core iron Fig. 6, A, A, A being for lifting and steadying purposes; long arm D is for back balance and should come past the centre of pipes. It is also advisable to put what is known as a breaker at C, for the cleaners to break the core iron easily. A breaker is a weak part of the iron, and may be caused by casting in a little piece of scrap, or slate, or may be left thinner than the rest of the iron. Put pieces of flat plate under

B, B, B, B, to carry the core, and make the core in the same manner as with taper pipe, using stout ropes for vent and shell rings for top of core, keeping them 4 in. or 5 in. apart. Ram up top and lift off. Take off shell rings, cutting away sand between them, mark core and lift out, and finish in the usual way. This method applies to bends, tees, crosses, and S-pipes up to about 18 in. Over 18 in. it is advisable to make in loam in the following manner:—

Let us suppose we have a pipe to make (Fig. 7). We will get a template (Fig. 8) and two strickles A and B (Fig. 8). Template should be 4 in. broad all round, and 1 in. thick, and ought to be outside of pipe, allowing 12 in. on each end for print. Flanges being screwed on, secure to bottom plate and set on template, resting flanges on brick. Build up all round to template, then build up inside to strickle A, which gives the outside of pipe. After drying, take off pieces C, C, C on strickle A, and strickle on thickness either with sand or loam, loam being usually preferable.

This gives the core box. Bed in the iron and build up core, using strickle B for top of core. Lift off template, turn upside down, screw on flanges, and build top part in the same way as bottom, using strickle A, with pieces C, C, C screwed on. Lift out core, take off thickness, and black off in the usual manner. This method is for bends of all sizes over 18 in. diameter, S-pipes, etc. If a double bend be required, the template would have the bend put on, and held in position with bar underneath, which could be easily filled up after template is taken off.

This method, I believe, is quick and cheap in the foundry, and in the pattern-shop there is no doubt about it being at least 75 per cent. cheaper than making even a skeleton pattern.

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A SET of schedules have been sent out during the month from the Census of Production Office which apply to trades concerned in electrical engineering, brass making, etc. Detailed particulars of output in the year of return, materials used, work given out, number of persons employed, capacity of engines, and amount of electricity used are required, while under the heading "Voluntary Information" particulars as to the number of machines in use and the amount of fuel consumed are invited.

RELATIVE VALUES OF THE PHYSICAL AND CHEMICAL EXAMINATIONS OF MOULDING SANDS.*

By Heinrich Ries.

It is probably well known to all who have looked into the subject, the successful use of sand for casting purposes, whether for moulds or cores, depends on certain physical qualities, such as bonding power, permeability, porosity, refractoriness, and durability under use, all of which should be naturally developed to the necessary degree, and few of which are usually increased by artificial means, except the cohesiveness, which is often increased in core sands and sands for steel castings by the addition of binders.

At the present time the suitability of a foundry sand is most often determined by a practical test, but few foundries giving any attention to a laboratory examination. Indeed, there seems to be doubt in the minds of many, whether a laboratory test is of value. At some works sieve tests are made, at others a chemical analysis, and in rare cases both are tried. Only a very small number of foundries buy their sands according to specifications.

With such a rarity of application of laboratory methods of testing it is therefore not surprising that no attempts have been made, so far as the writer is aware, to establish any standards to which sands should conform, much as these are to be desired. Such tests to be satisfactory should, of course, determine the degree of development of the several important physical characteristics in the sand, and if necessary look into the chemical composition. It may be stated here that the aim of the present paper is largely to call attention to the fact that the chemical analysis is of little value in most cases.

Cohesiveness.

The cohesiveness or bonding power of the moist sand is dependent no doubt on the amount and character of the clayey matter which the sand contains, and also on the coarseness of the sand grains.

No good test for determining the bonding qualities of the sand has so far been devised. The mechanical analysis, which shows us the amount of sandy and clayey matter present in the sand will, it is true, throw some light on this point, and

* Presented at the annual meeting of the American Brass Founders Association.

may be used as an approximate index of its cohesiveness. Thus, for example, of the two sands whose mechanical analyses are given below, No. 1 is coarse-grained and does not cohere even when moist, while No. 2, showing a considerably higher percentage of fine sand and clay, has good bonding qualities :—

Size mesh.	No. 1. Per cent. retained.	No. 2.
20	11.13	0.09
40	12.08	0.45
60	21.93	1.51
80	4.33	0.31
100	19.16	0.74
250	30.01	66.79
Clay	1.35	30.08

No.1.—Core sand, Rochester, Mich.
No. 2.—Stove plate sand, Conneaut, O.

It has been suggested that the cohesiveness be tested by the tensile strength, but the results do not in all cases appear to be satisfactory. Experiments made by Parmelee to determine this point showed that the tensile strength varied with the tapping which the sand received, and that there appears to be no direct relation between the average fineness and the tensile strength. It was concluded from this that the tensile strength did not stand in any direct relation to the bonding power.

Chemical Analysis.

Turning to the chemical analysis, we find at once that there is no relation between the bonding power, and plasticity and the percentage of alumina as is sometimes claimed. Two analyses will serve to illustrate this point :—

	No. 1. Per cent.	No. 2. Per cent.
Silica	66.12	70.24
Alumina	16.54	16.62
Ferric oxide	4.46	3.94
Lime	0.40	0.08
Magnesia...	0 22	0.09
Potash	2.67	1.41
Soda	0.35	0.74
Titanic oxide	0.14	0.46
Water	4.90	4.16
Moisture	4.15	2.42

No. 1 is a coarse-grained gravelly sand while No. 2 is a fairly plastic loam.

Refractoriness and Texture.

Foundry sands should be sufficiently refractory to prevent the pores closing up by fusion when the material is exposed to the heat of the molten metal. Were this to occur, there would be no openings for the gas to escape. Few tests have, to the writer's knowledge, been made to determine this point, but it would seem that a good method might consist of exposing pressed cubes of the moulding sand to a temperature equal to that which they are to be subjected to in casting. The degree to which they become fused or vitrified could then be determined.

Two sands showing the same quantity of fusible impurities will not necessarily be of equal refractoriness, for much depends on the texture of the material, the coarser one showing the greater refractoriness, other things being equal. In every sand we can roughly separate the grains into two groups—the silicious or refractory, and the clayey or non-refractory. If the sand contain only the former, it is apt to be very refractory (sand for steel castings), while if any clayish matter be present it will tend to flux with the silica grains if heated high enough, this fluxing action being the more intense the finer the silica particles.

The chemical analysis yields us information on this point only within very wide limits, permitting us to conclude that sand with a large quantity of fluxing impurities would not stand as much heat as a steel casting sand with, say, 98 per cent. silica. Among most sands it is difficult, however, to make any predictions what their fire-resisting qualities are likely to be if we have only the chemical composition to guide us, because texture plays such an important part.

The chemical analysis of a sand throws little light on its texture and structure, as an examination of any series of tests will show.

Permeability and Porosity.

The permeability of a sand depends on the size of the pores. The porosity can be defined as the volume of pore space between the grains. These two properties are, therefore, different and should not be confused. Two sands might have exactly the same percentage of pore space, but differ in their permeability, and the latter would be greatest in the one containing the largest pores.

Of the two physical properties mentioned, permeability is by far the more important, but so far as the writer is aware it is never tested, because to do so satisfactorily requires special apparatus. The foundryman sometimes attempts an approximate determination by taking some of the sand between his hands and blowing through it. In the laboratory it could be tested by determining the time required for a given volume of air, to pass through a given volume of sand, under a given pressure.

Such a test should, in the writer's opinion, be made on both the dry sand

and also on the moist sand tamped at the same pressure as it would be in the mould.

Texture and Permeability.

The finer grained a sand and the more clayey its character, the smaller are its pores and the lower its permeability.

As an example of the relation between texture and permeability we may take the two following sands, whose analyses are given herewith :—

Size mesh.	Per cent. retained.	
20	0.08	0.27
40	0.20	0.54
60	0.17	1.21
80	—	0.32
100	0.14	1.21
250	87.56	69.46
Clay	45.90	38.70

No. 1 is the more porous and permeable of the two, and allows the gases to escape more readily. This higher porosity is shown above, and is influenced evidently by the lower clay content.

It is probably reasonable to assume that there is a general but not very close relation between the porosity, texture, and permeability, and we should be justified in stating that of two sands having the same texture, the one with the greater porosity is probably the more permeable of the two. The measurement of permeability is a somewhat difficult operation, and requires special apparatus, but the determination of porosity is by no means hard to make, and gives us, when considered with the texture, an approximate gauge of the permeability of the sand.

Life of Moulding Sands.

Practically all moulding sands lose some of their desirable qualities after being exposed to the heat of the molten metal, and become "dead." A dead sand has had much or all of its cohesion destroyed and its texture altered, as well as having changed slightly in its chemical composition.

In order to consider a method of testing the life, one must consider what factors influence it. The deadness is no doubt due to several causes, such as dehydration of the clayish particles, resulting in the destruction of their plastic qualities, or the agglomeration of particles by fusion, thus increasing the coarseness and making it less plastic.

While a practical test is, perhaps, the best thus far known for determining the life of the sand, it seems as if the chemical analysis might give us a clue, assuming the loss in cohesiveness to be due partly, or even largely, to the dehydration of the clay. A clayey sand would show more chemically combined water than a silicious one. The degree of agglomeration that occurs when heated should also be observed.

In this connection the two sets of analyses given below are not without interest. No. 1 is an unused moulding sand from Richmond, Va. It is much used for general work in the local foundries, and bears an excellent reputation. No. 2 is some of the "dead" sand taken from the layer next to the metal :—

Mechanical Analysis.

Size mesh.	Per cent. retained. No. 1.	No. 2.
20	1.51	5.34
40	1.26	14.73
60	1.27	10.41
80	0.56	1.28
100	6.27	14 61
250	71.69	59.37
Clay	16.52	3.52

Chemical Analysis.

	No. 1. Per cent.	No. 2. Per cent.
Silica	83.49	82.32
Alumina	7.25	7.80
Ferric oxide	4.71	3.98
Lime...	0.36	0.54
Magnesia	0.35	0.41
Potash	1.30	1.64
Soda	0.41	0.81
Titanic oxide	0.30	0.22
Water	1.66	0.19
Ferrous oxide	—	2.38
Total	99 85	100.28

Comparison of these two sets of analyses indicates that there is a decided increase in the coarseness of the dead sand, due to a fusing together of the particles. The chemical analysis shows little difference between the fresh and the used sand, except in the case of the water which has been driven off, and there is also an increase in the iron, some having been absorbed from the metal. Much of it is, moreover, in the ferrous condition.

Conclusions.

It seems to the writer that the evidence which has been given points somewhat forcibly to the fact that the chemical analysis is to be but little relied upon in judging the qualities of a moulding sand, and that the physical tests are far more important.

In order to consider the question from as many standpoints as possible, we may inquire whether there is any relation between the chemical composition and the use to which the sand is to be put. Do brass sands, for example, show any chemical composition which distinguishes them from sands to be used for iron

castings? I believe that here again the evidence is distinctly in the negative :—

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.	No. 4. Per cent.	No. 5. Per cent.	No. 6. Per cent.	No. 7. Per cent.
Silica	71.60	86.80	57.63	79.36	79.81	81.50	82.21
Alumina ...	11.49	3.05	10.03	9.34	10.00	9.88	9 45
Ferric oxide ...	7.81	5.32	0.88	3.18	4.44	3.14	4.25
Lime	0.65	0.15	11.16	0.44	0.70	0.65	1.04
Magnesia ...	0 95	0.65	5.63	0.27	0.88	1.04	0.32
Potash	1.42	0.83	—	2.19	—	—	0.05
Soda	1.27	0.04	—	1.54	—	—	0.09
Titanic oxide	—	—	—	0.34	—	—	—
Loss on ignition	4.00	3.25	14.66	2.02	2.89	3.00	2.64
Moisture	—	—	—	2.74	—	—	—

In the table give above, Nos. I and II are both brass sands, but are quite dissimilar in their silica and alumina contents. No. III. is also classed as a brass sand, but bears no resemblance chemically to Nos. I. and II. Nos. IV. and V. are not dissimilar, and yet the former is a stove-plate sand, while the latter is used for making heavy castings. Of course, there are cases where two sands used for the same class of work are of similar composition, as Nos, VI. and VII.

To sum up, then, regarding the chemical analysis, it would seem that it gives little or no information regarding the bonding power, texture, permeability or use of the sand, the only case in which it is of value being in the selection of a highly silicious sand for certain work, such as steel casting.

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PROLONGING THE LIFE OF CRUCIBLES.*

By Dudley A. Johnson.

On the one hand, the crucible-maker works along the same lines as the manufacturing chemist or the druggist—that is, everything is analysed, weighed, and measured. He is not infallible, and consequently makes mistakes.

On the other hand, crucible-making is somewhat like bread-making. Even if you have the proper formula, it does not follow that you will make good crucibles.

Too many brass foundries follow in the old ruts; they let their tongs and shanks get out of shape, and don't notice any bad results; they leave their fuel out in the rain, and don't think it makes any difference; they throw heavy ingots into the pot and jab it with an iron poker, and the crucible seems to stand it all right. Gradually one bad practice after another creeps in, with the result that a complaint is made to the crucible-maker that his pots are not as good as they used to be.

Improvements in Manufacture.

I want to say here that better crucibles are being made to-day than ever before in history. At first it may appear that this is a rash statement — some phenomenal runs are on the old record books—but it must be remembered that in the old days the pots used were much smaller than at the present. Crucibles Nos. 35 and 40 formerly were about the average sizes in use, while to-day, Nos. 60 and 70 are nearer the average. Everybody knows that as the size increases the number of heats decreases. If 38 heats is the average on size 25, only about 30 heats would be expected on size 60, melting the same kind of metal. Another reason is that the mixture placed in the pot consisted almost exclusively of copper, tin, zinc, and lead, whereas at the present time the crucibles are charged with metals that contain percentages of aluminium, manganese, phosphorus, nickel, etc. Various fluxes are also used, and all these things have a detrimental effect on the life of a crucible.

The average length of a heat used to be 2½ hours, whereas to-day it is not uncommon to get off a heat in 1½ hours, and frequently the metal is poured within 45 minutes after the pot is placed in the fire, so that, if the crucible of to-day runs an even number of heats with one of 25 years ago, it must necessarily be a better pot to stand up under the more severe strain of a hotter fire to reduce the metal in half the time, and the injurious effects of various new ingredients which go into it. The records show a greater number of heats than in the old days, notwithstanding this severe usage.

Prolonging the life of a Crucible.

I am positive that a large percentage of the brass founders can increase the life of their crucibles materially if they will but follow up their shop practice, and in proof of this I want to cite an instance.

Some years ago, one of my friends in the trade happened to mention to me

* Presented at the annual meeting of the American Brass Founders' Association.

that on a No. 30 crucible his average heats were in the neighbourhood of 25.

I told him if he was not getting more than 25 heats out of a No. 30 pot melting this kind of metal, that there was something radically wrong, and that by looking over his shop practice perhaps we might see where the trouble was.

We found, in the first place, that the furnaces which he was using were very wide and very shallow. There were 6 to 8 in. of coke space on each side of the pot with about a 4-in. bottom under the pot. It was a natural draft furnace, and the air coming in from the grate bars below and passing up to the flue hole, carried the hottest part of the fire off to one side of the pot, with the result that the amount of fuel used was twice as much as necessary to melt the charge. I suggested a furnace that was narrower and deeper, allowing about 3 in. of coke space on each side of the crucible, and 6 or 8 in. at the bottom. One furnace was built on this plan, and the result was so satisfactory that all the rest were rebuilt.

I also advocated the use of a larger crucible, as the most economical results are obtained by using the largest crucible that can be conveniently handled, consistent with the kind of castings to be poured..

We then took up the matter of crucible storage. Two rooms were built with solid brick walls with gratings in the bottom and flues at the top, arranged so as to pass all the waste heat from the furnaces through these rooms on the way to the stack. One room was used for burning cores, the other was used for crucible storage, and dampers were placed so that the heat could be diverted into either of the two rooms as needed. This kept the crucible constantly at a high temperature, and enough pots were always on hand so that they could be thoroughly seasoned before it was necessary to put them into use.

An improvement was noted in the life of the crucible, and we then turned our attention to the fit of the tongs. We had new tongs made of the grab pattern, an overhead trolley was used, and the pots were lifted out without any squeezing. Two pairs of tongs were used, one for the crucible when it was new, and another after it was partly worn out and had grown smaller. The shanks were overhauled and the clips discarded.

The keeping of an accurate record of the heats was next in order, and also a record of the different furnace tenders, and it was found that some furnace tenders would require 25 per cent. more crucibles, and use 25 per cent. more fuel in the same work than the man alongside.

To sum up, at the last report, this man had a general average of 45 heats on a No. 50 pot over a period of nearly a year and a-half, as against his old record of 25 heats on a No. 30 pot.

What has been done in one brass shop can readily be accomplished in another. I have here a list of the causes and remedies of the failures of crucibles, and I will briefly point them out.

Storage.

Crucibles should be stored in a warm, dry place, either back of the furnaces on the flues, where the hot gases from fresh fires will not strike them, or on the top of the core oven. It is generally conceded that a crucible properly stored in a foundry is from 10 to 20 per cent. more efficient at the end of a year.

Annealing.

Before using, the crucible should be slowly brought up to a heat of 250 degrees Fahr., or over, but if this is accomplished too quickly a scalp is the result, or an internal fracture, which will afterwards cause a leak. A No. 200 crucible requires about 10 hours to bring up to this heat. The pot should then be immediately filled with metal, and a heat taken off without allowing it to cool.

Tongs and Shanks.

The fit of the tongs is very important. On crucibles above size No. 50, tongs with double prongs should always be used, and preferably of the "grab" pattern. The upper prong prevents the pot from wobbling, and the "grab" device prevents squeezing. The tongs should grip the crucible below the bilge and lift it without undue pressure, as if it were in a shank or a basket. When a crucible is at white heat it is soft and leathery, and many crucibles are ruined by forcing the tongs together and pounding a ring on the handles. It is a great advantage to have two sets of tongs for every crucible; one for the new pot, and one for the pot half used, which is smaller. The tongs should be "shaped up" at frequent intervals.

Shanks of the scissor pattern are hard on crucibles, because of the tendency to seize the pot too high up and squeeze it. The plain ring pattern shank is the best. The ring should be wide, and tapered to conform to the contour of the crucible.

It is not necessary to use clips with this style shank.

The Fuel and the Furnace.

The fuel should be dry. Wet coke produces moist gases and steam, which causes alligator cracks. Sulphur in the fuel shortens the life of the crucible materially.

At the beginning of the heats the top of the crucible should never set higher than the bottom of the flue-hole, and if the work will permit, the space around the pot and at the bottom should be sufficient to hold enough fuel to take off the heat without re-coking. A long, narrow furnace is preferable to a short, wide one.

The drafts and dampers, if arranged to produce a reducing atmosphere, will lengthen the life of the melting pot. An oxidising flame is always unfriendly to a plumbago crucible.

Clinkers and Slag.

The clinkers should be removed from the sides of the pot as the tongs are put on, and from the bottom of the pot before it is set on the floor. It should always be set on a bed of dry sand; never on hard bricks.

In melting scrap and dirty metal, the inside of the pot becomes thickly coated with slag, and this should be removed with a scraper.

It is bad practice to leave the metal on the fire after it is ready to pour; soaking in this way an extra half-hour has a more injurious effect on the crucible than the entire previous heat.

Varieties of Metals.

The melter must not expect as many heats in melting one metal as another. From three heats in melting nickel, to five or six in melting steel; approximately 25 are reached in melting copper, while the heats run into the 40's in melting composition.

Where it is necessary to use a flux to clean the metal, it must be expected that the life of the crucible will be shortened, as nearly all fluxes attack the binding material in the walls of the crucible to a greater or less extent.

The Heats.

If the crucible can be recharged and put back into the fire at once, a greater number of heats will result than if it is set away and allowed to cool between each heat.

The time of the heat is also to be allowed for. If the heat is taken off in an hour or an hour and a-half, the crucible will not last as long as with the lighter punishment of a two or two and a-half hour heat.

Don't leave any metal to cool in the crucible, but pour until the melting pot is entirely empty. In the parlance of the shop, don't leave the crucible so that you will find a button in the bottom when it has cooled off. These buttons may have small threads or spikes of metal which will attach themselves to the crucible walls, and they tear the walls of the pot as they come out; or, if left in the crucible, when the next heat is taken off, they expand more rapidly than the walls and break the pot.

Be very careful not to allow the ingots to wedge in charging the crucible, but place them in loosely, or expansion will break the pot.

Treatment of Hot Crucibles.

See that the crucible has a good bottom to rest on in the furnace. Some foundries use brick for the crucible to set on after it settles down, and these bricks should be smooth and level. If they get on edge or are set cornerwise, the hot crucible full of metal settling down on them, or on a hard piece of clinker, will have a hole punched through the bottom. Remember there is a great deal of weight above the bottom of this leathery pot.

Be very careful with the use of the poker, as it is an easy matter to punch a hole through a hot crucible.

In addition, we might say that it is important to always place the pot in the centre of the furnace, so that there is an equal fuel distribution all round, It is also good practice to turn the pot partly around after each heat; that is, if the lip of the pot faces the flue-hole it should gradually be turned after each heat. This insures equal wear on all sides of the crucible.

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CORE MAKING.*

By Archie M. Loudon.

The following is my experience with a variety of cores:—

Radiator Cores.

These are safest and best made of bank or beach sand, mixed with oil in propor-

* Presented at the annual meeting of the American Foundrymen's Association.

tion of 1 part oil to 40 to 60 parts sand. Bake quickly until well browned. The result will be easily vented cores, and a ready extraction from the casting. This is important, as the work must be entirely clear of the core before testing.

Steam and Water-Boiler Cores.

Use bank or beach sand with about 25 per cent. mash, or add floor sand to make the core stronger without having to use too much oil. The addition of oil is a particular matter and not readily controlled, for with too much oil the cores are more difficult to bake, and become so hard that portions are left inside the castings, causing serious damage at times when these castings are used. The old sand helps the binding of the sharp sand, and as the castings are usually $\frac{3}{8}$ of an inch thick, the oil is completely burned out, and the materials easily extracted. The mixture best suited for this class of work is 75 per cent. sharp sand, and 25 per cent. of old floor sand. Then take 1 part of oil to 50 or 60 of the sand mixture.

Small Cores for General use.

These are safest when made of the mixture for radiator cores, if the castings are to be light or medium in weight. Small cores for heavy castings should be made from a good strong fire sand and moulding sand with a somewhat refractory binder, such as flour and graphite. This is necessary to get a good clear hole in the casting.

Small cylinder cores should be made from an oil-sand mixture. Similarly the barrel core, as there is less liability of blow-holes from such cores than from any others known. Further, when the iron is machined, a clean, smooth surface is left for the tool. The iron is also liable to remain softer, hence this mixture should be used for port cores, exhaust and steam chest cores. Use straight beach sand and oil, in proportion of 1 oil to 40 to 60 parts sand.

For barrel cores about 20 per cent. of coarse moulding sand, mixed with 80 per cent. beach sand, with oil 1 to 50 of the sand makes an excellent open core. Use this on cylinders up to 10 in. diameter. When the section of the casting becomes heavier, a stronger mixture is necessary.

Large Cylinders.

Large cylinders necessitate a strong but open mixture to obtain good results. Fire-sand, moulding-sand, sharp-sand, each $\frac{1}{3}$. Mix with glue water, 2 lbs. of glue in 3 gallons of water, the solution being brought up to the boiling point only. Use this glue water to 100 lbs. of the said mixture. Dampen the sand with additional water, it being understood that this is for large cylinder cores for immediate use, as well as dried moulds in one form or another. The reason for using glue is that the difficulty from gases is reduced to a minimum.

Large Cores.

Large cores used for a variety of routine work must be made by the foundryman with the different sands and binders he has, and the mixtures varied to suit his needs. A variety of formulæ will give equally good results. My preference is as follows:—For ordinary cores, $\frac{1}{3}$ coarse moulding sand, $\frac{1}{3}$ beach sand, and $\frac{1}{3}$ old sand. Mix these, and take 1 part of dry compound with 36 of the sand mixture.

Where the large cores should be strong, use $\frac{1}{3}$ coarse moulding sand, $\frac{1}{3}$ fire sand, and $\frac{1}{3}$ old sand, and for each 36 parts of the mixed sand use 1 part of dry compound, and $\frac{1}{2}$ part flour. I mention this particular binder as it gives me the best results with the sands peculiar to my locality. Other binders, both liquid and dry, will go equally as well with the sands they are specially suited for.

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Mixtures for Die Castings.—For the manufacture of castings in accurately-made moulds, to take the place of machined ones, the following mixtures, says the "American Machinist," are useful:—

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.	No. 4. Per cent.
Zinc	73.75	71.70	73.80	46.20
Tin	14.75	19.00	12.00	30.80
Aluminium...	6.25	1.00	3.40	20.40
Copper ...	5.25	5.00	10.60	2.60
Lead	none	2.00	none	none
Antimony ...	none	.30	none	none
Iron	none	none	.20	none

The Nos. 1 and 2 mixtures are used for general work, such as would be used to replace brass castings. Nos. 3 and 4 are harder, particularly No. 4, and are used for special work where very hard metal is desired. No. 1 is really the mixture that is most extensively used, and gives a casting that has about the same strength as cast iron.

REPAIRING WATER JACKETS OF MOTOR CYLINDERS.

Most foundrymen who have come in contact with motor car work will be familiar with the trouble of broken or burst cylinder water-jackets, caused through allowing the water to freeze therein. A successful method of brazing or repairing the break is very welcome, saving, as it does, the trouble and expense of re-casting. In the illustration, Fig. 1, will be seen a cylinder badly damaged in the manner stated; the second figure shows the same cylinder after having been repaired by Lea's metallurgical process, as carried on by Messrs. Lea & Son, of Runcorn. We understand that by this process no twisting or warping of the cylinder is experienced.

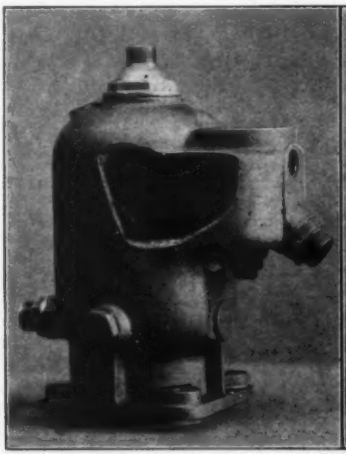

Fig. 1. Fig. 2.

A Broken and Repaired Water Jacket

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At the London Bankruptcy Court recently, the first meeting of creditors was held under the failure of Mr. H. K. Ingham, director of Catton & Company, Limited, steel founders, of Leeds. The Chairman stated that accounts had been filed showing gross liabilities £15,533 (£5,980 unsecured), and assets disclosing a surplus of £2,050. Resolutions were passed for the appointment of Mr. S. H. Beser as trustee to wind up the estate in bankruptcy.

MANGANESE COPPER IN THE FOUNDRY.

The value of manganese copper as a deoxidiser is often overlooked or ignored in the foundry, but at the same time it must not be considered a panacea for all the ills that metals are heir to.

Manganese copper may be purchased in different percentages of manganesse, but the most useful is the 30 per cent. alloy. This is a very hard metal, of great strength. A freshly-cut surface has a tin white appearance, which on exposure rapidly tarnishes to a dull yellow. It is usually cast into small cubes or strips, and these appear dark-red by reflected light. In the cube form it is very difficult to accurately weigh out small quantities, as it is almost a physical impossibility to break the cubes with a hammer. It is advilsable to melt a quantity, and pour it into water. By this means, granulated metal is obtained, and the small pieces are very useful for making up weights.

Manganese copper is cheaper than phosphor tin or phosphor copper, and may often be used where the presence of phosphorus would be injurious or inadmissible.

It is curious that often not a trace of manganese is to be found in the cast metal to which manganese copper has been added, but if the skimmings are analysed they will be found to contain

large percentages of manganese. This is to be accounted for by the fact that the manganese combines with oxide and sulphur in the molten metal, and rises to the surface as a thick scum.

For instance, several lots of gun-metal scrap, which had been badly "burnt," were melted, and 2 per cent. manganese copper added. Samples taken from the cast product gave, on analysis, the following figures: —

	Per cent.	Per cent.	Per cent.
Copper ...	85.47	86.02	85.74
Tin	7.53	7.71	7.52
Zinc	5.94	5.03	5.74
Lead... ...	0.90	1.08	0.82
Manganese	nil	0.18	nil

It will be seen that in one case only was any manganese present.

However, the value of the treatment can easily be demonstrated. The tensile strength of the "burnt" metal was 9.48 tons, whilst after treatment it rose to 15.25 tons.

Again, a mixture of copper 76, tin 7½, zinc 15, and copper manganese 1½, was melted, cast into ingots, and then remelted. This gave on analysis: —

	Per cent.
Copper	80.50
Tin	6.92
Zinc	10.59
Lead	0.80
Manganese	nil

On the other hand, a mixture for manganese bronze was made up as follows, using only the best materials: —

Copper 50, zinc 41, manganese-copper 8, aluminium 1.

This was melted, run into ingots, remelted, and cast in sand. The copper manganese contained by analysis 25.98 per cent. manganese, and the castings were of the composition: —

	Per cent.
Copper	61.21
Zinc	35.65
Manganese	2.04
Aluminium	0.46

The theoretical quantity of manganese added was 2.08 per cent., so that only 0.04 per cent. was lost in two meltings.

I have analysed many so-called manganese bronzes, and with the above exception, failed to find more than traces of manganese.

It is essential that to get the greatest value out of it, the copper manganese must be thoroughly well stirred into the bath.

Another useful purpose for this alloy, and one about which very little is at present known, is its introduction into aluminium alloys. The strength and appearance of aluminium castings is often spoilt by small "pinholes." These are due to oxide in the metal, and may usually be eliminated by the judicious use of manganese copper.

For example, an aluminium alloy was found to give very poor castings, with a tensile strength of 6 tons per square inch. The addition of 2½ per cent. manganese copper gave a greatly improved appearance, and increased the tensile strength to 8.8 tons per square inch.

Aluminium alloys give an increase in the tensile strength, with a lowering of the elongation, up to 2 per cent. manganese, above which percentage the breaking strain falls. The aluminium manganese alloys at present are of little commercial value; but for correcting oxidation or overheating, manganese copper is invaluable.

The use of this alloy in aluminium foundry practice is at present only in its infancy, but when more systematic experiments are carried out it will probably be found of the utmost utility. In brass founding it is coming to be recognised as a factor, not only in the manufacture of manganese bronze, but in the casting of common brass and gun-metal. At the same time, too much must not be expected of it, and it must be used with judgment and clear understanding.

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A PNEUMATIC ROLL-OVER MOULDING MACHINE.

THE pneumatic roll-over moulding machine shown in the accompanying illustrations, designed and built by the Tabor Manufacturing Company, Philadelphia, solves the problem of turning over large moulds and drawing the patterns on large machines of this type without the use of cranes or hoists. The flask is rolled over and the pattern withdrawn by a centrally located air cylinder.

Fig. 1 shows the machine in its normal position to receive the flask and shows a half flask rammed up ready to be rolled over. Fig. 2 shows the machine after the flask has been rolled over and delivered on the levelling device before drawing the patterns. The equalising support is Y-shaped, and ensures an accurate bearing for the bottom board. A central spring in the hub of the levelling device supports the

upper portion upon which the flask rests. This supporting spring holds the moving portion of the levelling device in contact with the bottom part of the flask at

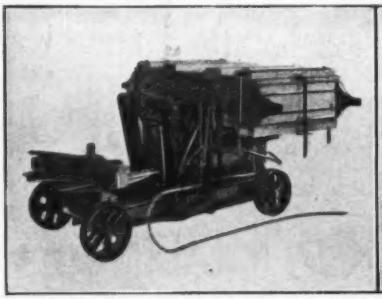

FIG. 1.—TABOR ROLL-OVER MACHINE IN NORMAL POSITION.

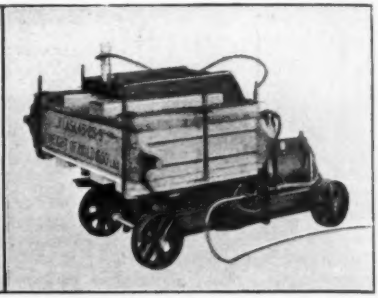

FIG. 2.—FLASK ROLLED OVER AND DELIVERED ON LEVELLING DEVICE.

three points, until the spherical surfaces at the three points come in contact, when the levelling device is securely locked and held in position until the flask is rammed. When the flask is taken off the levelling device, the upper portion is raised from contact with the lower portion by the spring and is again ready to receive an irregular flask.

Fig. 3 shows the machine with the pattern drawn clean from the sand, and Fig. 4 shows the pattern turned back and the mould ready for delivery. All of the foregoing operations, with the exception of ramming and clamping, are accomplished by power, by simply opening and closing the air valves.

The pattern board is equipped with a very heavy vibrator, and the patterns shown on this machine have parallel sides, 8 in. high. The accurately machined guides on this machine make it possible to draw deep parallel patterns without the aid of draft. The flask shown is 45 by 28 in. and 9 in. high, and weighs 650 lbs., although flasks and pattern boards weighing up to 1,000 lbs. can be handled on this machine, which is well adapted for jobbing foundry use, and eliminates all of the heavy manual labour on large work. —("Iron Trade Review.")

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EXTENSIVE improvements are at present being carried out at the works at Falkirk of the Callendar Iron Company. A large new warehouse is being erected, and the grinding shop is being very considerably extended.

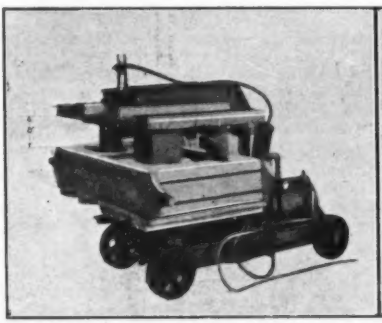

FIG. 3.—PATTERN DRAWN FROM THE SAND.

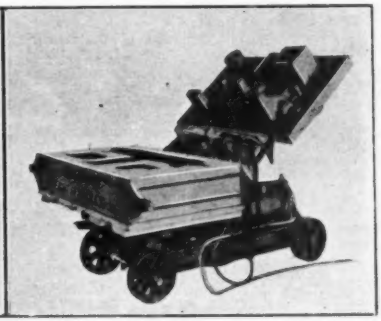

FIG. 4.—PATTERN TURNED BACK.

LIQUID FUEL IN THE BRASS FOUNDRY.*

By W. N. Best.

The success obtained from the use of liquid fuel depends largely upon the hydrocarbon burner used. There are many different burners upon the market to-day, of which the majority are of the internal mixing or injector type. In these the fuel and the atomising agent flow out in the same direction. In another type of burner, known as an external mixer, the fuel flows down upon a sheet of steam or air, and is thus carried into the furnace or firebox of boilers. While the more volatile fuels require very little atomisation, yet if the burner used is not of such form and capacity as to insure the thorough atomisation of any grade of liquid fuel, the foundryman will be in a sad predicament whenever a shipment of low grade fuel is sent him. I always recommend an external mixing burner, as in Fig. 1, having the fuel orifice below the atomiser cavity. This prevents the fuel from solidifying or carbonising over the atomiser slot; and as the fuel passes out of the nose of the burner on a perpendicular line, while the atomising agent passes out horizontally, the thorough pulverisation or atomisation of the fuel as well as the even distribution of the flame in the combustion chamber is effected. I also recommend the use of a special regulating cock, Fig. 2, which ensures both a steady flow of fuel to the burner and the minute regulation of the quantity. The plug of this regulating cock has a V-shaped knife edged opening on the intake side, while the exit has a large opening, and thus the residuum which may be in the fuel cannot stop the flow. If a globe or needle valve be used to regulate the fuel supply to the burner, the space the valve parts from the valve seat is so slight that the residuum in the fuel soon collects therein, causing great annoyance. This is especially noticed when low gravity fuels are used, for then often the valves become so clogged that the supply of fuel is entirely cut off.

Theoretically, it requires 13½ to 14½ lbs. of air to effect the perfect combustion of 1 lb. of oil. Allowing 14 lbs. at 62 degrees F., it would require 184.97 cubic feet of air to effect the perfect combustion of 1 lb. of oil, or at 100 degrees F. it would require 197.34 cubic feet. In actual practice it has been found that it requires from 17½ to 19½ lbs. of air to effect the perfect combustion of 1 lb. of oil. Allowing 19 lbs., at 62 degrees F., 249.68 cubic feet are required, or, at 100 degrees F., 267.82 cubic feet. Considering one gallon of oil to weigh 7½ lbs., practically it requires 142½ lbs. of air to effect the perfect combustion of one gallon of oil, or 1,872 6-7 cubic feet of air at 62 degrees F. At 100 degrees F., 2,009¼ cubic feet are required. If compressed air be used as atomiser, only about one-sixth of the air needed for the perfect combustion of the fuel is obtained through the burner, the rest being furnished through an ordinary air nozzle placed immediately under the burner. This air is at 3 or 4 oz. pressure. As to the cost of compressing air per cubic foot, the condition in no two plants are precisely alike. In some works steam-driven compressors are used, while in others there are compound compressors.

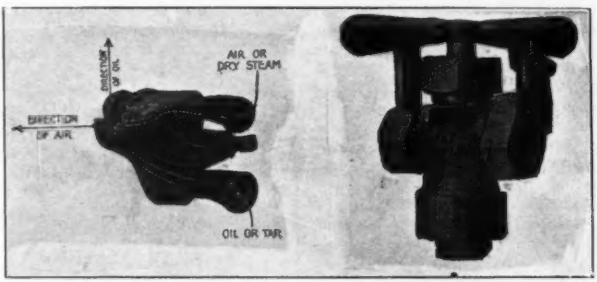

Fig. 1.—Hydro-Carbon Burner.

Fig. 2.—Safety Regulating Cock.

* From a paper read at the Toronto meeting of the American Brass Founders' Association, June, 1908.

Some employ electrical power to compress the air, while others use gasoline engines. Again, if steam-driven compressors are considered, the many grades of coal vary as much in calorific value as they do in price.

To those who contemplate using liquid fuel in their plants, a few words in regard to the supply tank, etc., may be of interest. The fuel supply tank (varying in capacity from 1,000 to 10,000 gallons) should be placed some distance from the buildings, and should be provided with a vent pipe extending at least 2 ft. higher than the shop building, and placed 10 ft. or more from any chimney or smoke stack. Ten or 12 lbs. pressure is usually maintained on the fuel line, and an ordinary steam-driven brass lined duplex pump or a belt-driven triplex plunger pump may be used to pump the fuel. A pulsometer with gauge and a pressure valve with an overflow pipe connecting with the storage tank should always be placed upon the fuel line, so that when one or more of the burners are closed off an even pressure will be maintained upon the fuel supply pipe line to the other burners by the release of excess oil through the pressure valve, the fuel returning to the storage tank through the overflow pipe.

Whatever the type of furnace, I always recommend that a combustion chamber built on scientific lines be used, for it directs the course of the heat in the furnace and provides for the union of the air requisite for perfect combustion with the fuel before they reach the furnace proper. Those who have given liquid fuel a thorough test have proven conclusively that it is the incomparable fuel for all work connected with the brass foundry, core drying as well as melting, etc.; but in order to obtain the highest possible efficiency modern equipment must be used in every detail, the fuel must be thoroughly atomised by the hydrocarbon burner, the fuel supply must be constant at all times, and the furnaces must be so constructed as to meet every requirement.

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THE first meeting of creditors was held at the London Bankruptcy Court recently under the failure of William Reed & Company, machine engineers, of London, Newcastle, and Glasgow. Resolutions were passed winding up the estate in bankruptcy, with Mr. W. C. Bourner, C.A., as trustee. The company have been adjudged bankrupts.

METHOD OF OBTAINING A CIRCULAR AND UNIFORM CHILL IN ROLLS.*

BY THOMAS D. WEST.

IN casting a chill roll the general conditions are as shown in Fig. 1. The metal in the outer part, *a* (shown in black) will present a white appearance for a depth of ¼ to 2 in. or more, while that in the necks and body, *b* and *c*, will be mottled or nearly gray. In *a* the carbon exists in the combined form, while in *b* and *c* it is largely graphitic. The fact that the shrinkage of the former in solidifying is considerably greater than that of the latter is an important consideration in the manufacture of rolls. If two test bars, under 2 in. square in section, be cast from the same ladle, the one in an iron and the other in a sand mould, the contraction of the former will be about twice that of the latter.

When a chill roll mould is being filled with metal the cooling qualities of the chill *d*, Fig. 2, cause the outer body of the inflowing metal, as it comes in contact with the chill face *e*, to solidify so rapidly that a contracting crust is formed in 2 to 5 minutes, according to the diameter of the roll.

The formation of the sustaining crust is easily explained as follows:—On the side *e*, Fig. 2, the metal is shown as it fills the mould, while on the opposite side *f* the conditions that exist 2 to 5 minutes after the roll is cast are indicated. It is seen that the chill *d* has ceased to offer any support to the crust *o* by reason of the space created at *x* and that the chill *d* might be removed, so far as the body of the roll is concerned, if that were practicable. It is also evident that the metal inside of the crust *a* and at the necks of the roll is still in almost as hot and liquid a condition as when first poured. Its fluidity may, in fact, be maintained for 20 to 60 or more minutes, according to the size of the roll. This condition serves to explain in large part the difficulty of obtaining satisfactory chill rolls. The thin, almost semi-molten, crust *a* must sustain during the early period of the operation the static pressure of the confined liquid metal. The result in obtaining a chill roll castings is affected by small variations in the level of the mould, the quality of the metal, the temperature in pouring, the catching of fins at joints or crevices in the face of the chill, the opera-

* Paper read before the American Society for Testing Materials.

tion of feeding devices, etc. It is no wonder, therefore, that with a process so sensitive and difficult to regulate, the losses range from 10 to 30 per cent. of the nominal output by the systems now in use, and that the rolls cast in this manner are rarely truly circular with a uniform thickness of chill.

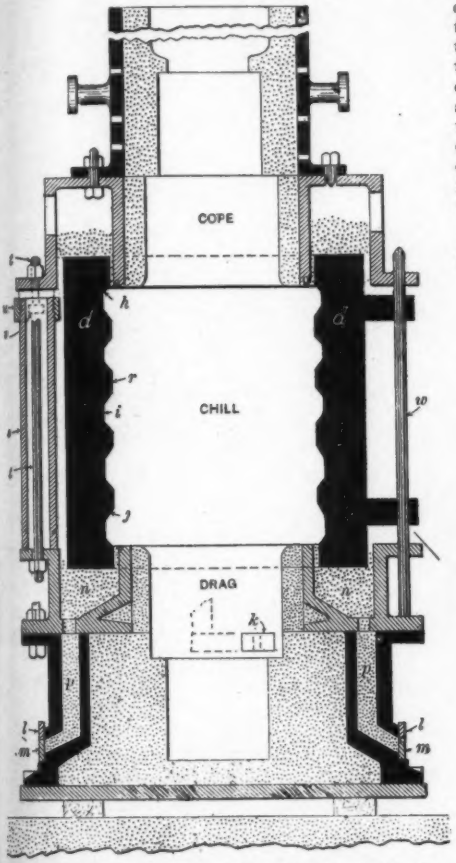

FIG. 3.—SECTION OF IMPROVED CHILL, SHOWING METHOD BY WHICH IN SETTLING IT IS KEPT IN CLOSE CONTACT WITH THE ROAD METAL.

For the successful casting of chill rolls the appliance should be such as to enable the chill *d* to remain constantly in intimate contact with the crust *a*, and that it be controllable likewise vertically to take care of the contraction in that direction. Numerous devices designed to overcome the evil effects of a contracting crust have been tried, but none of these meet the requirements in anything like the same measure as the appliance represented in Fig. 3.

The chill *d*, Fig. 3, has grooves, *i*, which are shown in an exaggerated form in the illustration. These grooves vary in height and number to suit varying requirements, and exhibit gradual variations from bottom to top in the inclination of the sloping surfaces *h* and *j* for the purpose of taking care of the vertical contraction of the solidifying crust. This serves to insure a close contact between the upper slope of every groove and the corresponding bead cast on the chill roll during the entire period of settlement to final rest, which is brought about in the following manner.

After the metal is poured through the swirl gate *k* the band *l*, operated by a lever not shown, is moved, which serves to bring holes in the band to positions opposite *m*, this action allowing fine sand and other flowable material to run out of the partitions *n* and *p* at any desired speed. The chill *d* is lowered by this action, causing the sloping surfaces *h* and

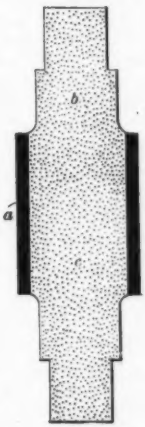

FIG. 1.—SECTION OF RED AND CHILL.

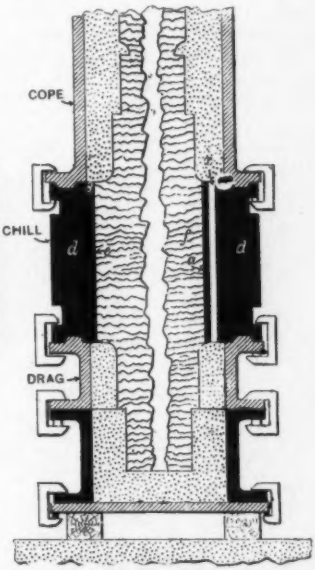

FIG. 2.—SECTION OF ROLL MOULD, SHOWING CRUST FORMATION SOON AFTER POURING.

j to remain in intimate contact with the upper sloping surfaces of the beads cast on the chilled surfaces of the roll.

In the first roll cast by this device the chill commenced to settle in about 2 minutes after the pouring was finished, and in about 7 minutes the grooved face *r* had slid over the bead face *i*, thus giving direct indication of the internal action of the contracting chill crust, a matter never before accomplished.

In this device the outer diameter at the points *i* is such that when the roll is cold enough to be removed from the chill it can be hoisted out of the latter, or the latter off the roll, as may be desired. The body of the sample roll cast in this chill was 11 in. in diameter and 14 in. long. When put in the lathe to be turned it was found to be perfectly round and of an exact thickness of chill at all points of its circumference.

Five other devices, differing in the form of the grooves and the method of insuring contact, have been designed. In one case the chill remains stationary while the cope, casting and drag can be lowered. In another the crust is depressed. In a third the cope and casting settle into the drag, while the chill remains stationary. In some of these devices the grooves, or hugging faces, are so arranged that they remain in constant contact with the beads on the roll until the latter is removed from the chill or its moulds.

Roll turners claim that the extra labour in turning up chill rolls to remove the slight projections or beads cast on the rolls by this system is, on the average, much less expensive than that required to turn up smooth faced chill rolls that are not truly circular, manufactured by processes now in use in our chill roll foundries.

Returning to Fig. 3, the cope is supported from the drag independent of the chill by means of four wrought-iron tubes *s*, bolts *t*, adjustable sleeves *u*, and set screws *v*. Three or four long turned rods or pins, *w*, serve to centre the chill and cope with the drag.

——o——

At a meeting of Pearson, Sons & Company, Limited, held at the Nitshill Iron Works, Nitshill, near Glasgow, recently, the statutory resolution was passed for the voluntary winding-up of the company. The directors propose to reconstruct the company on a much larger scale. Mr. J. M. Davies, jun., C.A. (of Messrs. Davies, Tait & Company, 168, St. Vincent Street, Glasgow). was appointed liquidator.

FLUXES FOR STEEL MELTING.

(By an Indian Correspondent.)

A correspondent, in a letter signed "B. S. S." in the April number of the Foundry Trade Journal, asks for information concerning a flux for melting steel for castings. The query, though not exactly ambiguous, leaves much to inference. When one speaks of melting brass, one is invariably understood to imply the use of a crucible and a coke or gas-fired melting hole, though both reverberatory and cupola melting is practised. When iron casting is spoken of, we at once infer the cupola method, though in this also, the reverberatory is often used. In special cases, as, for instance, the casting of small cylinders for motor cars and the like, crucibles are, or should be, used for the sake of cleanliness. The correspondent, however, did not state what system of steel-melting he was using, which it is necessary to know, as so much depends on this. In the system he is employing, the trouble most probably lies.

There are five or six processes extant for the making of steel for steel castings on the large and small scale of manufacture, and three or four for simply melting. It seems safe, however, to assume that "B. S. S." has not at his disposal a big installation dealing with a large output. The nature of the question implies that he is one of the large number of engineers or founders who have found it impossible to get along without steel castings for special purposes, and that he is producing them on a small scale by the crucible process with a converted or improvised plant, the inefficiency of which is responsible for the thick running steel. This inference may, of course, be wrong.

The difference in the effective casting temperature of steel compared to that of ordinary alloys is so great, that to attempt to melt or manufacture it without properly constructed furnaces must result in failure.

In answering the question as to the best flux for steel, using the term flux in the same sense that it is accepted in the melting of copper alloys, the author unhesitatingly plumps for heat as the best flux in the world. If heat is put into a steel-melting furnace of any design, no flux is needed; but if thick metal is obtained, the trouble will not only be in the inability to cast properly and a correspondingly high wastage, but bad and dirty metal will result.

This does not imply that "cold" casting gives bad results as to quality of metal, for, though not generally stated, it may eventually be proved that low temperature casting, with all other conditions correct, is the best for general strength, if not for good external appearance.

Half an hour with a Le Chatêlier pyrometer would probably convince "B. S. S." that his furnaces are wrongly designed, or, if up to date, are badly worked. One does not hear of fluxes for use in the steel foundry as one does of the use of borax and zinc, etc., in brass melting pots.

The function of a flux generally, so applied, is to clear the bath of scoria and increase the fluidity of the metal by effecting the separation of the metal from this scoriaceous matter without sensibly increasing the temperature of the whole. The addition of "physics" to steel foundry ladles is, of course, not unknown, but is not generally talked about; whether they are called fluxes or by other names is merely a question of nomenclature. Chief amongst these is aluminium added to the ladle before pouring, or stirred into the crucible on removal. Two pieces of aluminium (commercial stick), about the size of a walnut, are sufficient for a shank, and will increase the fluidity to a remarkable extent, besides tending to release any gases it contains; but by what means aluminium does this is a debatable question, on which much might be written without really assisting the founder to get his metal any thinner. The best and surest remedy, however, apart from the preventive methods mentioned, is to employ Thermit cartridges, ready-made, or to purchase the loose Thermit powder and make the cartridges. The consequent disturbance or agitation of the metal might preclude the addition of Thermit to a well-filled crucible, but in a suitable ladle the effect of this addition, well carried out, is marvellous. It is not safe to put Thermit on the bottom of ladles in the same way as aluminium, as the lining of the ladle suffers, but it must be introduced by any approved method into the body of the bath, so that the action may be near the bottom, but not touching.

A rough but effective method adopted by the author for making these additions to steel is as follows, and requires only the making of a special can to hold the mixture, and intelligent manipulation :—

The can, C, shown in the sketch, is of the ordinary cylindrical shape with a conical socket A, soldered on top of the lid B and concentric with it. The socket hole may, if desired, be continued through the

lid by punching the latter prior to soldering.

The band of the lid is made deep to ensure a good grip, as the lid has no catch, but carries the weight. Any size can may be made, but a standard size socket is retained. The whole is made of thin sheet iron.

When using, the mixture is weighed in, and the lid fitted. A long iron rod, T, bent if necessary, but roughly tapered to the socket, is introduced into the socket and the tin given a few turns to fix it, and, if necessary, a small wooden wedge used to tighten. The can is quickly plunged beneath the surface of the metal, and, being momentarily protected by a film of moist air and probably a crust of slag pushed downwards, time is allowed to get the can well under the surface before fusion takes place.

In dealing with small quantities of steel, small quantities only of the Thermit are needed, as the heat developed is tremendous; moreover, the amount of scum is small, and the time required for reaction short.

As regards the common fluxes or "physics" used in the actual melting of the steel in pots, the philosopher's stone is still undiscovered; but where the thickness of the metal is due in part to included slag or impurities, probably a mixture of equal parts of salammoniac and fluorspar is the best, added either with the melt or stirred into the molten mass. These substances, especially fluorspar, have the power of increasing the fluidity of the slag, probably by reducing the melting point and allowing an easier separation.

The "Foundry Trade Journal" Bookshelf.

The Moulders' Text Book.

By Thos. D. West.

This book is really the second part of "American Foundry Practice," by the same author, dealt with in last month's FOUNDRY TRADE JOURNAL. It presents methods and rules for obtaining good, sound, clean castings, and gives detailed descriptions for making moulds of a difficult nature. The articles in this book, like those in the other, have been considerably revised and extended in order to bring them up to date. Diagrams and drawings are freely distributed through the pages to assist in making clear the author's explanation. He opens with a lecture on sound castings, and gives in detail the results of his own experiments to that end. Following this is a discourse on defects in structural castings. In touching on mental and physical development in moulding, he points out very bluntly the effect of mental incapacity and the advantages of education in the work. Considerable stress is laid also on attention to trifles—the lack of which too often mars excellent work. A knowledge of geometry is also recommended. Proceeding then to deal with different pieces of work, the making of cylinders and castings to finish, and the moulding and casting of cylinders to procure clean valve-faces are treated. Other branches of cylinder work are described, and among the difficult jobs dealt with is the moulding of a jacketed cylinder. Moulding propeller wheels in loam and a hydraulic hoist casting in sand are other items in the section entitled "High-art Moulding."

After the manipulation of cores is dealt with, the procuring of clean-finished castings from green-sand moulds comes under consideration, followed by methods and rules for green-sand and general moulding. A variety of information is crowded under this heading.

Miscellaneous chapters treat with such subjects as foundry facings, welding steel to cast iron, mending cracked castings, ovens and pits, ladles, chilled rolls, moulding machines, pouring gates, etc. There are also contributed chapters on melting small quantities of iron, making a curved pipe from a straight pattern, moulding pipes on end, making an air vessel, and moulding gear wheels. A further section deals with cupolas and the melting of iron, including the fuels, blast and general construction of cupolas. Following this are forty-six reports of cupola workings in various American States, which present valuable material for a comparison of different men's cupola practice.

After some remarks on the melting and mixing of steel with cast iron to obtain strong or chilled castings, the author concludes the book with several chapters on foundry cranes. The different classes of cranes—steam power, friction power, hand power, travelling etc.—are each treated, and their respective advantages explained. The book is a very acceptable addition to the first part, and should find a place on every foundryman's book-shelf.

The publishers in London are :—Chapman & Hall, Limited.

Rylands' Directory.

THERE has recently been placed on the bookshelf the tenth edition of this Directory, which covers the colliery, iron, steel, engineering, and allied trades. The volume is an unique one, for it not only is a Directory of the greatest collective group of manufacturers carried on in the United Kingdom, but it presents up-to-date lists of the collieries, iron works, steel works, and allied establishments carried on in all the leading industrial countries of the world. While there is much in the book that is not relevant to foundry work, there is also a mass of information presented which will prove of considerable use to all who are conducting foundry concerns. For instance, there are lists of blast furnaces and pig-iron makers, with the brands of every pig-iron being smelted in the kingdom. The different kinds of pig-iron are also given, as well as spiegeleisen, ferro-manganese, ferro-silicon, silicon-spiegel, silicious and chrome iron. What will also prove of interest to foundry managers is the list of engineers' specialities. This section is a directory in itself, and gives the manufacturers and merchants of almost every item of engineering plant and equipment, including foundry cupolas, cupola linings, annealing furnaces, brass-melting furnaces, tumbling barrels, core boxes, vents, ropes, ovens and compositions, crucibles, blowers, moulders' flasks, blacking, ladles, rattlers, foundry sand, cranes, etc., besides machine tools, and a host of other items too numerous to mention.

The lists of iron and brassfounders, which cover something like 2,500 firms, are also interesting features, every firm of any importance being included. Brassfounders only are given also in a separate list.

The Directory is published by *The Iron and Coal Trades Review*, 165, *Strand, London, W.C.* The price is 25s. cloth bound, and 30s. Morocco bound.

OVERHEAD TRAVELLING CRANES.—We have received from Messrs. Vaughan & Son, Limited, of West Gorton, Manchester, their 1908 book, dealing with overhead travelling cranes. This book describes many classes of cranes and hoists suitable for foundries and engineering shops, and the information is interleaved with excellent reproductions of photographs showing the different types referred to, the firm's own shops and also various works where their cranes have been installed. A good deal of information regarding the different types of cranes is given, with copious notes on shop equipments, etc. Electric cranes, hoists, winches, and capstans, and handpower apparatus are described and illustrated, the whole making what is really a useful reference book for all connected with foundry work. Those about to install apparatus cannot but profit by the notes on the design of roadways, speeds, the position of control, electric power, motors and hoisting ropes for overhead travelling cranes, which are given as an introduction to the actual description of the cranes.

HOLIDAYS ON THE CONTINENT.—A neat little illustrated booklet has been forwarded to us describing the beauties of a series of tours in the less known districts of Holland, North Germany, the side valleys of the Rhine, Austria, the Belgian Ardennes, and Scandinavia, easily and inexpensively reached by the Great Eastern Railway Company's Harwich Route to the Continent.

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MESSRS. F. W. CROSS and A. A. P. D. STONE, constructional and manufacturing engineers, etc., Walsall, trading under the style of Cross & Cross, have dissolved partnership.

THE NEW YARD AND MARSHSIDE IRON WORKS AND ROLLING MILLS, at Workington, were sold by public auction recently, at Workington, for £6,500, to Messrs. T. W. Ward, Limited, of Sheffield.

CORRESPONDENCE AND QUERIES.

VERTICALLY CAST IRON PIPES.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I have examined the samples of the faulty pipe forwarded by "Remedy," with the description of the method of producing, but fail to see any discrepancy in the method of melting or the moulding. It is essential that the moulds should be poured as soon as possible after being got ready for so doing. In the unturned sample submitted I find the fault in that case to be a piece of cinder embedded, and there is only one remedy for that, viz., to have a good runner head about 5 in. deep, and cover the inlets with a shutter or some pieces of thin bright tin. The latter will melt by such time as the runner box is full of metal, thus avoiding the passing of any cinder or dirt into the mould. With regard to the turned portion submitted, make the allowance over and above the required casting 5 in. instead of the 1 in., as stated, with the increased thickness as shown. It will be just as easy to cut this off as the 1 in. piece in the machine shop. Use the same mixture, which I find makes a good soft, and at the same time close iron, this latter being essential for such castings. Just prior to tapping out the metal, place in the bottom of the ladle a piece of pure aluminium from 0.02 to 0.05 per cent., to free the metal from gases and oxide compounds in solution. If used as stated, it will act perfectly, but if applied in any other manner, a large part of the aluminium is consumed without accomplishing any good. It destroys the oxide solutions under all circumstances, even if the iron is already dull, by forming aluminium oxide, which is taken up by the slag. Follow the above methods and they will prove a true remedy for the troubles stated.

C. E. ALLEN.

MATCH-BOARDS FOR REPETITION WORK.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I find plaster of Paris, taken all round, a very durable material to use for odd sides. If it is at all practicable, two odd sides should be made (top and bottom). Apart from the time occupied,

which is usually a day, and a box used, the cost of the materials is not great. The plaster parts I am working at present did not cost in materials 2s., their dimensions being 18 in. by 12 in. by 4 in. Six patterns are in a box, the weight of the castings 18 lbs., 360 castings per day being produced. This same plaster was made two months ago, and is still in use.

There are other methods of producing castings in the shop, but I would question whether the machine can compete when initial outlay is taken into consideration.

Yours, etc.,
"H. F."

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In reply to C. H. & Company, matches that I have had considerable experience with, have been variously of clay, plaster of Paris, Val-de-travers, boiled oil and litharge, mahogany, babbit, soft wood, and paraffined wood, this latter being an open-grained hard wood, preferably oak or ash. But all things considered, for matches suitable for carded patterns that are expected to be kept in working order for an indefinite length of time, the litharge match is the best in point of durability, and is composed of one-half dry new moulding sand and one-half parting sand, boiled linseed oil, litharge, and put through a fine riddle; the finer the sand the more perfect will be the joint. Measure the match frame to get the right amount, and do not make it deeper than necessary. From ¾ to 1 in. is the proper depth for ordinary matches. The back boards, battens, and frame should be constructed of good white pine, and put together with laps and screws. If there are any deep lugs or flanges in the patterns, let them cut through the bottom board, which bottom board should be screwed on the frame after the match is rammed. Having prepared the dry mould for the match, remove the screws from the bottom board, thus disconnecting the frame, then place the frame in position on the drag mould ready to receive the mixture. Shake some parting sand, or better still, a little lycopodium, on the mould to prevent the mixture from sticking to the patterns. To prepare the mixture for a match, say, 14 by 14, a small handful of litharge is enough, this should be well mixed with the sand when dry, and the mixture of sand and litharge moistened with boiled linseed oil and well mixed until the whole mass is the consistency of well tempered moulding sand. If too dry, it will crumble easily. If too wet, it will not dry hard for a long time. Ram it up as one would any other sand match. Small clout nails can be placed in the match close to the pattern before drying, at points that are liable to wear or become injured. When finished, rap the patterns enough to show a slight enlargement of the match, draw them out to see if the parting is right, and then return patterns and let dry. This will require about 48 hours, and should for this purpose be placed where it can receive a moderate amount of heat, After it is thoroughly dried, remove the patterns and apply two coats of thin shellac, which improves the match very much in finish and durability. When not in use, the patterns should be kept in the match to avoid shrinking. If properly made and handled, a match of this composition will last, as before stated, for an indefinite length of time.

C. E. ALLEN.

SAND FOR ALUMINIUM ORNAMENTS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Will any of your readers tell me of a mixture of sand suitable for moulding aluminium ornaments that require a very smooth finish.

Yours, etc.,
"F. F."

PROPELLER MOULDS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Referring to the sketch showing a cheaper method for covering propeller blades, which appeared in your July issue, I consider the method shown in the June issue is more adaptable and cheaper to a foundry which makes a speciality of propellers of all shapes and sizes. Wrought-iron bars are more pliable than cast-iron bars, and the hangers can be so arranged to keep these bars the desired distance from the temporary pattern. They can be bent to suit the fillets generally found necessary to strengthen the blades with the boss; no bricks are necessary when wrought iron is used, and no breakage results. I firmly believe, also, that a safer lift can be assured by using my method. For instance, supposing a 17-ft. propeller is to be built, I don't believe the majority of moulders

would be content to use 1½ in. square cast-iron bars in the covering of the blades. I do admit that "R.'s" method may be used by firms who do not make propellers regularly, and to whom the expense of better tackle would be a consideration.

Yours, etc.,

WILLIAM ASHCROFT.

MOULDING SAND FOR MEDALLIONS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In reply to Bronze Founder's, *re* the above, I am not conversant with the address of any agents who supply French sand, but if your correspondents will write to Messrs. J. W. & C. J. Phillips, London, they will be able to supply a very fine sand, such as the Mansfield, Charlton and the Birmingham Cemetery. Any of these I think will be found suitable for the work in hand. Had the alloy that was being used been stated, I might have been able to recommend a special sand mixture for the purpose, as such articles are frequently made of silver, zinc, and aluminium in permanent moulds, composed of an admixture of plaster of Paris and Bath-brick.

C. E. ALLEN.

SWEDISH IRONS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I have read with interest your report of Mr. Thomas's paper at the meeting of the Birmingham Metallurgical Society on May 9, and as I have had a very considerable experience of the Swedish pig-iron trade perhaps I may be allowed to say a few words on the subject.

That there are some very good brands of Swedish pig on the market for foundry work, I am quite prepared to admit; but so far as I have been able to judge, there is only one make of Swedish foundry pig which will give anything like the tests Mr. Thomas mentions, viz. :—42 to 44 cwts. transverse on the usual 2-in. by 1-in. bar on knife edge supports the usual distance apart; and a tensile test of 16 to 18 tons per square inch.

Surprising tests of this iron have recently been made on a special quality supplied particularly for chilling, thus :—Out of twelve tests the average transverse test was 43.6 cwts.; the deflection 5.5; the tensile 17.98 tons per square inch; the depth of chill averaged 1 in. The analysis was :—C.c. .73 per cent, C.Gr : 2.31 per cent., total C. 3.04 per cent., Si. 1.23 per cent., Mn. .45 per cent., P. .266 per cent., S. .12 per cent. I think it will be admitted that this is an iron which can, at the present time, have no equal in the world.

In regard to Mr. Thomas's remarks respecting iron being spoiled in remelting, may I be permitted to point out that the great mistake which all foundrymen make in melting Swedish pig is to smelt at too low a temperature. If they would only remember that the purer the iron the greater is the heat required to properly melt it, we should hear less of the trouble known as "shotty" fracture.

Time after time I am called upon in the course of my business to see castings, the fractures of which show "small shot," as the workmen call it. This is due entirely to the heat for remelting being insufficient, and wherever my advice has been followed and an increased temperature allowed. the trouble has entirely disappeared.

M. Parker was quite correct when he said that there were very few Swedish cold blast foundry irons. As a matter of fact, practically the whole of the Swedish pig-irons are really only fit for steel-making.

If any of your readers are interested in an iron which will give the tests mentioned by Mr. Thomas, or as mentioned above by myself, for either strong castings or chilled work, I shall be only too pleased to give them the name of the firm supplying it.

Yours, etc.,

"G. H. F."

ON the occasion of the recent official celebration of his birthday, the King bestowed a large number of honours, of which two names, Mr. Robert Hadfield and Colonel Charles Allen, are well-known in the foundry trade. Mr. Robert Abbott Hadfield, who was made a knight, is chairman and managing director of Hadfield's Steel Foundry Company, Limited, of the Hecla and East Hecla Works, Sheffield, and a past president of the Iron and Steel Institute (1905). Colonel Charles Allen, J.P., who also received the honour of knighthood, is chairman of Henry Bessemer & Company, Limited, and managing director of the Ebbw Vale Steel, Iron and Coal Company, Limited.

LIST OF NEW INVENTIONS.

Specially compiled for the FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, 77, Colmore Row, BIRMINGHAM.

12,856. G. E. SCORBY-SMITH. Improvements in or relating to gas producers for manufacturing steel.

12,951. D. WILKINSON AND LAKE & ELLIOTT. Improvements in or connected with the construction of pattern plates for use in casting metals.

13,120. THE PEARLITE STEEL COMPANY, LIMITED, AND A. C. J. CHARLIER. Improvements in the treatment of low-grade steels.

13,184. O. A. ZANDER. Improvements in electric melting furnaces, pots, ladles, and the like.

13,400. C. JONES. Improved steam boxes for bilge suction.

13,964. W. WITTER. Improved process for recovering the volatile metals and metalloids, particularly zinc, lead, antimony, arsenic, and the like, out of products (slag, ore, and the like), containing such especially from slags of lead and copper smelters.

14,709. G. BROWN. Improvements in one-way clutches for velocipedes and other suitable machinery.

1907.

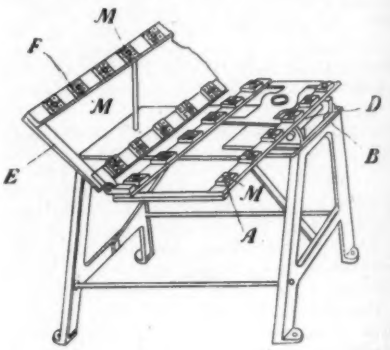
17,305. T. H. CHURCHILL, Toronto. Improvements in and relating to casting machines.

This invention has relation to the type of casting machine wherein two sets of mould members are connected to each other so that they may be brought together or separated, and according to the present improvements, a frame is adapted to carry each group of separable mould members, the said frame being mounted in such a manner that when the moulds are brought together they may revolve in either a horizontal or a vertical plane.

The illustration shows a perspective view of a casting machine with the mould members positioned to receive the rails and fittings.

The machine illustrated shows a method of using this type of mould for casting parts of metal beds and similar articles, but the principle may be applied to any suitable use.

The mould members A are arranged as shown and fastened to a rigid frame B and are made to revolve on a hinged member D. Hinged to one side of B is a corresponding frame E, and mould



members F are positioned to register with the members A when the case is closed. The molten metal is poured in through the ingates M.

When the machine is closed and the fillings are in position between the mould members, the whole is then swayed on its hinges till it is vertical and locked in this position. The casting then takes place on one row of the mould members, and when this is completed the frame is revolved and the second now comes into place in a similar manner.

—o—

MR. JOHN THOMPSON, maker of the "Thompson dish-ended" boiler, of Wolverhampton, has opened a London office at 63, Queen Victoria Street, E.C.

THE shareholders of John Brown & Company, Limited, have been invited to subscribe for 4 per cent. debentures in order that the full amount of the authorised capital might be made up. The debentures are a first charge, and are limited to £1,000,000.

MR. K. R. PEARSON, Sanctuary House, Tothill Street, Westminster, London, S.W., has been appointed agent for the locomotives, and Mr. J. M. Gummerson, Finsbury Pavement House, London, E.C., agent for the other manufactures of A. Borsig, Tegel, Berlin.

TRADE TALK.

MR. J. ANDERSON has started business as a consulting engineer at 128, Hope Street, Glasgow.

MR. A. J. COLVILLE has started business as a consulting engineer at 11, Bothwell Street, Glasgow.

MESSRS. BRIDDON & FOWLER have purchased the Horsfield Iron Works, Bredbury Station, Stockport.

A FIRE broke out recently at Mr. George Green's Foundry at Aberystwyth, which was partially destroyed.

MR. W. MATTHEWS has commenced business at 39, Victoria Street, London, S.W., as a consulting engineer.

MESSRS. OWENS & CASE, consulting engineers, have moved to 47, Victoria Street, Westminster, London, S.W.

MESSRS. THOMPSON & HUNTER, 1, Leadenhall Street, London, E.C., have removed to 3, Lombard Street, E.C.

MR. R. WEATHERBURN, Finsbury Pavement House, London, E.C., has ceased to represent A. Borsig, of Berlin, in this country.

MR. J. F. MOSS and MR. C. K. EVERITT have been elected directors of Edgar Allen & Company, Limited, Tinsley, Sheffield.

MESSRS. G. ROBSON and F. CROOKES, engineers, Sheffield, trading as George Robson & Company, notify a dissolution of partnership.

THE Manchester business of J. W. Jackman & Company, Limited, has been transferred to the Vulcan Works, Chester Road, Manchester.

MR. F. MOUNTFORD, City Chambers, Broad Street Corner, Birmingham, has removed to the Fremo Works, 66A, Granville Street, Birmingham.

MESSRS. M. T. SABINE and J. SABINE, mechanical engineers, Swadlincote, Derbyshire, trading as Sabine Brothers, have dissolved partnership.

THE FOWKES AND WOOLLEY FOUNDRIES, LIMITED, Victoria Foundry, Osmaston Road, Derby, have removed to the Old Mill, Siddals Road, Derby.

MESSRS. J. W. SMITH and S. H. CHAMBERS, engineers, etc., Leicester, who traded under the style of Smith & Chambers, have dissolved partnership.

MESSRS. SOUPER & CALLAGHAN, have established themselves in business at 46, Grosvenor Chambers, Deansgate, Manchester, as engineers and agents.

ON the invitation of the directors of Ashmore, Benson, Pease & Company, Limited, their officials and foreman recently paid a visit to the Franco-British Exhibition.

P. H. MUNTZ & COMPANY, LIMITED, West Bromwich, have appointed Mr. A. H. Hasell, Queen Street, Melbourne, as their agent for the Commonwealth and New Zealand.

MESSRS. PERTWEE & BACK, Nelson Iron Works, Great Yarmouth, have appointed Mr. C. Hoecker, Hopetoun House, 5, Lloyd's Avenue, London, E.C., as their London agent.

MESSRS. POOLEY & AUSTIN, 25, Victoria Street, London, S.W., have been appointed sole agents in London and the Home Counties for Engineering Instruments, Limited.

MESSRS. W. J. REID and H J. MEEKING, engineers, etc., Leadenhall Chambers, St. Mary Axe, E.C., trading as Reid, Meeking & Company, have dissolved partnership.

A DISSOLUTION of partnership is notified in connection with Messrs. F. Beanland and J. W. Perkin, engineers, etc., Leeds, who traded under the style of Beanland, Perkin & Company.

DAVIDSON & COMPANY, LIMITED, 13, Victoria Street, Westminster, London, S.W., have removed to larger and more centrally situated offices at Egypt House, New Broad Street, London, E.C.

MR. E. A. COOKE, 143, Bath Row, Birmingham, has acquired the patterns of the Reliance Brass and Iron Foundry Company, Limited, Birmingham, which company recently went into liquidation.

MR. A. S. E. ACKERMANN, secretary of the Society of Engineers, has successfully carried through a scheme for amalgamating the Society with the Civil and Mechanical Engineers' Society, of which he is also secretary.

MR. W. H. CASMEY, the patentee of the "Yorkshire" boiler, of Standard Buildings, City Square, Leeds, has been appointed the sole representative in Yorkshire for the engine built by Carels Bros., Limited, of Ghent, Belgium.

IN consequence of the great demand for Rees roturbo pumping machinery, etc., for which Thomas Parker, Limited, hold the sole British manufacturing rights, a new company is being formed, styled the Rees Roturbo Manufacturing Company, Limited, which will take over the business of Thomas Parker, Limited.

PERSONAL.

MR. D. E. HIGHAM has been elected a director of the New Century Engine Company, Limited.

MR. JOHN SANDFORD has been appointed manager for John Priest & Son, Limited, Castle Iron Works, Bristol.

MR. ALBERT LADD COLBY, the well-known consulting and inspecting engineer, of New York, has lately been in London.

MR. J. H. B. NOBLE has been elected a director of the North-Eastern Railway Company, in place of Lord Armstrong, resigned.

MR. J. BARROW, a partner of Messrs. Thomas Shanks & Company, engineers, Johnstone, N.B., has retired from active association with the business.

THE late Mr. H. Davies, J.P., a director of the Ebbw Vale Steel, Iron and Coal Company, Limited, left estate of the gross value of £100,815 4s. 5d.

MR. W. L. HEPTON, Lord Mayor of Leeds, who received the honour of knighthood during the King's recent visit to Leeds, is a son of the late Mr. W. Hepton, the founder of the Yorkshire Brass and Copper Works, Leeds.

THE directors of Mather & Platt, Limited, invited their workpeople to a gathering at Belle Vue Gardens, Manchester, recently, in order to celebrate the 70th birthday of Sir William Mather, and also his jubilee as head of the firm. The employés took advantage of the occasion to present Sir William with an illuminated address and a handsome golden loving cup, in appreciation of his courtesy and care for the general welfare of those in his employment during the many years he has been head of the firm.

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DEATHS.

MR. W. ELLIOTT of Elliott & Garrood, Limited, Ingate Iron Works, Beccles.

MR. G. BINNIE, manager of Jones & Campbell, Limited, Torwood Foundry, Larbert.

MR. J. WALLACE, of Glassingall, and son of the late Mr. D. Wallace, of Messrs. William Baird & Company, ironmasters, Gartsherrie.

MR. THOMAS KIRK, managing director and secretary of the Carlton Iron Company, Limited, Carlton Iron Works, Stockton, aged 72 years.

MR. J. DICKINSON, the well-known North of England marine engineer, aged 83 years. The deceased gentleman was chairman of John Dickinson & Sons, Limited, marine engine builders, Sunderland.

MR. G. B. BRADSHAW, of Manchester, for many years a prominent iron and steel manufacturer. The deceased gentleman had the distinction of becoming managing director of the Midland Iron Company, Rotherham, at the early age of 30 years. Leaving the Midland Iron Company, he founded the Rotherwood Iron and Steel Company at Woodhouse Mill, where he remained for many years.

MR. J. L. MILNE at his residence, Elderscroft, Peebles, aged 56 years. The deceased gentleman was a son of the late Mr. John Milne, and a grandson of the original James Milne who founded the firm of James Milne & Son, of Edinburgh, now James Milne & Son, Limited, Milton House Works, Abbey Hill, Edinburgh. Mr. Milne ceased to take an active part in the business in 1892, but remained a director until 1904, when he retired altogether.

MR. W. OLIVER, formerly a well-known engineer, of Chesterfield. The deceased, who was in his 80th year, established many years ago the Victoria Foundry, in Knifesmith Gate, which business was afterwards transferred to a limited company, Mr. Oliver being the managing director. In consequence of difficulties which subsequently arose the business, then known as the Broad Oak Works, was purchased by Mr. Charles P. Markham.

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BLACKSTONE & COMPANY, LIMITED, of Stamford, were awarded a gold medal for their oil engine exhibit at the recent Wirral and Birkenhead Agricultural Society's Show, as well as a silver medal for a swath turner. The company also received a gold medal for their oil engines shown at the East Kent Show, at Deal.

MESSRS. HOWARD BROTHERS, proprietors and manufacturers of the "Dey" time registers, 40, Paradise Street, Liverpool, and 100B, Queen Victoria Street, London, E.C., who have turned their business into a limited liability concern under the style of the Dey Time Registers, Limited, have removed their London office and showrooms to more extensive premises at 75, Queen Victoria Street, E.C.

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BLACKFRIARS, MANCHESTER.

NEW COMPANIES.

MALLINSON BROTHERS, LIMITED.—Capital £500, to acquire the Mytholm Foundry, Hipperholme, near Halifax.

HARDIE & MUNRO, LIMITED.—Capital £4,000, to acquire the business of Hardie & Munro, ironfounders, Loanhead.

AYR STRUCTURAL AND STAMPING COMPANY, LIMITED.—Capital £5,000, to carry on the business of ironfounders, etc.

J. P. HALL & COMPANY, LIMITED.—Capital £35,000, to carry on the business of electrical and mechanical engineers, etc.

HOLLINGS & GUEST, LIMITED.—Capital £5,000, to take over the business of general engineers carried on by Hollings & Guest.

BROWN & PARSONS, LIMITED.—Capital £1,000, to acquire the engineering business carried on at 63, The Parade, Leamington.

CASTING & COMPANY, LIMITED.—Capital £2,000, to carry on the business of ironfounders, etc., at Lochview Foundry, High Bonnybridge.

DEY TIME REGISTERS, LIMITED.—Capital £50,000, to take over the business of Howard Bros. Registered office: 40, Paradise Street, Liverpool.

BLASBERG ENGINEERING COMPANY, LIMITED.—Capital £5,000, to acquire the engineering business of C. Bradshaw, 78, Cannon Street, Manchester.

DODD & OULTON, LIMITED.—Capital £20,000 in £5 shares, to acquire the business of brassfounding carried on in Liverpool, etc., as Dodd & Oulton.

CHISHOLM, GRAY & COMPANY, LIMITED.—Capital £7,000, to acquire the business carried on in Birmingham as the Chisholm Manufacturing Company.

LUPTON BROTHERS, LIMITED.—Capital £15,000, to acquire the business carried on at the Grange Iron Works, Grange Lane, Accrington, as Lupton Brothers.

GENERAL CONSTRUCTIONS MACHINERY SUPPLY COMPANY, LIMITED.—Capital £1,200, to carry on the business of manufacturers of and dealers in machinery, etc.

COMPAGNIE GENERALE DE CONSTRUCTIONS METALLIQUES ET CHAUDRONNERIES, LIMITED.—Capital £32,000 in £1 shares. Registered office: 6, Holborn Viaduct, E.C.

ROBERT NEILL & SONS, LIMITED.—Capital £20,000 in £10 shares, to acquire the engineering business carried on at Bangor, co. Down, as Robert Neill & Sons.

H. W. WARD & COMPANY, LIMITED.—Capital £40,000, to take over the business of tool makers carried on at 85-89, Lionel Street, Birmingham, as H. W. Ward & Company.

ERNEST SCOTT & COMPANY, LIMITED.—Capital £30,000, to acquire the engineering business carried on at London, Manchester, and Glasgow, as Ernest Style & Company.

CHARLES HOWSON & COMPANY, LIMITED.—Capital £20,000 in £10 shares, to acquire the shipbuilding, etc., business carried on at Kirkdale, Liverpool, as Charles Howson & Company.

BATEMAN, DAVIES & COMPANY, LIMITED.—Capital £1,000, to acquire the business carried on at Osborne Engineering Works, London Road, Wycombe Marsh, Bucks, by J. T. Bateman.

JOHN BIBBY, SONS & COMPANY (ST. HELENS), LIMITED.—Capital £60,000 in £10 and £1 shares, to acquire the business carried on at St. Helens as John Bibby, Sons & Company, and to carry on the business of copper smelters, etc.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

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The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1907-8.	1906-7.
Iron—Scotch pig warrants ... ton	*55 6	*65 0
—Middlesbro' warrants ... ... ton	50 1	56 10½
—W.C. M/nos Bessemer ... ... ton	58 6	82 0
—Stock, Scotch, tons	1,000	2,097
Copper—Chili bars, GMB ... ... ton	£59 7/6	£86 15 0
—Stock, Europe & afloat... ... tons	—	—
Tin—English ingots ton	£137 15 0	£186 10 0
—Straits ... ton	£137 10 0	£182 10 0
—Stock, Ldn. Hind and afloat ... tons	—	13,183
Lead—English pig ton	£13 12 6	£20 10 0
Spelter—Ord. Silesian ... ... ton	£19 0 0	£23 5 0
Quicksilver—(75lb.) bottle	£7 17/6-£8 0 0	£6 16 0-£7 0 0
Antimony—Regulus ... ... ton	£32 10 0	£43 0 0-£45 0 0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in. ...	5 2 6	to	5 7 6
,, 3 to 4 in.	4 15 0	to	5 5 0
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in.	4 12 6	to	4 15 0
,, 18 to 24 in.... ...	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 15 0
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 5s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 6s. 0d.; all per ton f.o.b., London. Copper (clean), £54 0s. 0d.; brass (clean), £39 10s. 0d.; lead (usual draft), £12 10s. 0d.; tea lead, £10 15s. 0d.; zinc, £15 5s. 0d.; all per ton delivered merchant's yard.

SILICA FIRE BRICK Co.,

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GROUND GANISTER,

Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Better than Fire-clay Bricks for Cupolas.

Established 1863.

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PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

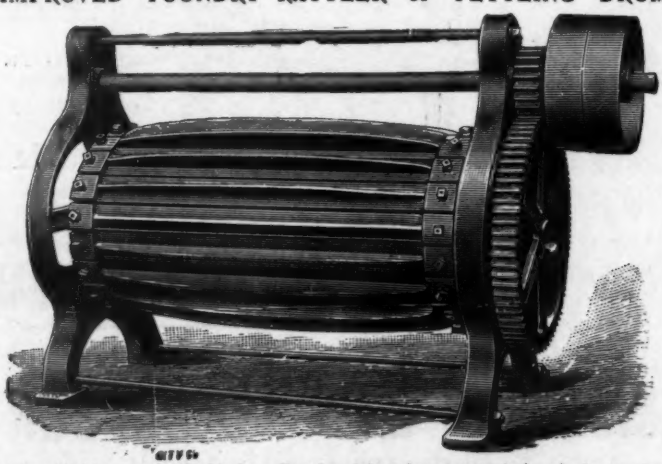
FOUNDRY EQUIPMENTS,

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



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"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

"Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD."

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FOR REPETITION FOUNDRY WORK.

ILLUSTRATION OF
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WHERE A DEEP LIFT IS REQUIRED CAN BE OPERATED BY
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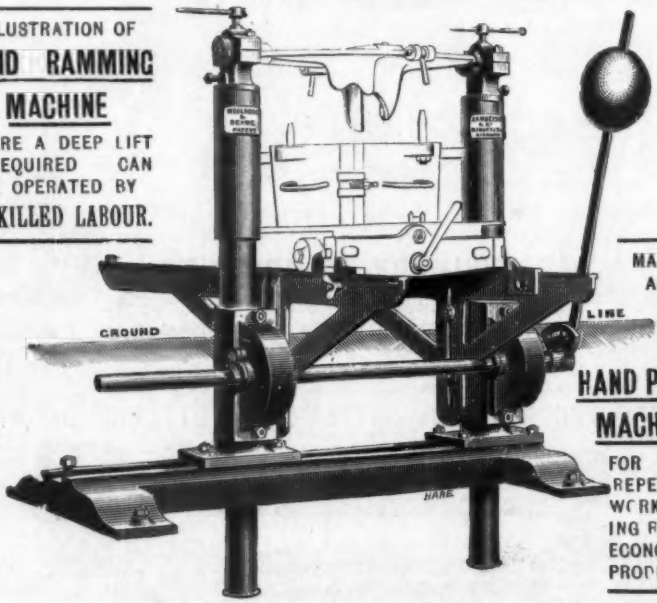

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PATTERN MAKER wants situation, age 25; strict teetotaler; excellent time-keeper; steady job preferred.—H. W., 77, Hamstead Road, Handsworth.

FOREMAN, experienced, wanted, for Shop Manufacturing, Shafting, Gearing, etc.; must be well up in latest practice; good time-keeper and organiser.—Address, stating experience and wages, Box 163, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

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"Baker's" No. 4, 11½ in. outlet, as new.
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" No. 5, A " 4 in. "
Air Compressors (3) for Sand Blasting, etc.
Address:—
J. LIGHT, WOLVERHAMPTON.

FOUR Morgan Salamander Plumbago CRUCIBLES, No. 150, holding 300 lbs. each; only used once for Bronze. What offers? Also 5-ton Weston's Differential PULLEY BLOCK; only used 3 or 4 times.—Address Box 160, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

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(Continued.)

CHEMICAL ANALYSES OF FOUNDRY MATERIAL.

PIG-IRON, BRASS, BRONZES, SOLDERS, COMPOSITIONS, &c.
Standard Methods. Prompt dispatch of results. Special Contract Charges.
CHEMICAL & ASSAY LABORATORY,
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DESULPHURISING SULPHIDE ORES.

THE Proprietor of BRITISH LETTERS PATENT No. 17,580, 1901, desires to LICENSE BRITISH MANUFACTURERS to work in Great Britain said Patent, which relates to the Desulphurisation of Sulphide Ores. Instead of first roasting the ores to oxidise the sulphides to sulphates, and then treating it in a converter, the sulphides are completely desulphurised and cinerated in the converter in one operation. This is effected by mixing with the raw sulphide ore a suitable quantity of calcium sulphate or gypsum or calcium sulphide and subjecting the mixture in a converter to the action of a current of air. The process is described in detail in the Specification, from which also many of the advantages attained are apparent. The Proprietor is also willing to consider reasonable propositions for the Sale of the Patent.
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MESSRS. C. A. ROBINSON & CO., Anchor Iron Wharf, East Greenwich, S.E., are Cash Buyers of every description of Scrap Iron and Steel, Brass, Copper, and all Metallic Residues. Telephone, 94 Deptford.

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MANUFACTURERS OF

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Specially prepared for Bessemer, Siemens, and Crucible Steel Castings, Cores, &c.

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WE are *SPECIALISTS* in
WEIGHBRIDGES and **WEIGHING APPARATUS**
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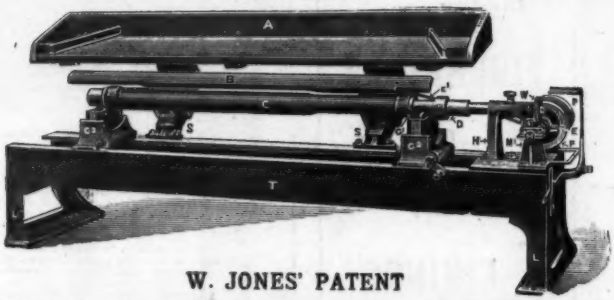

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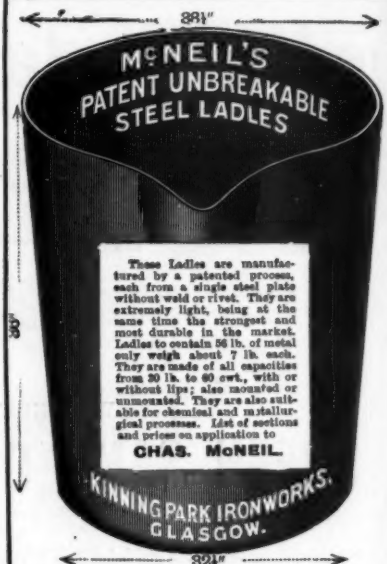
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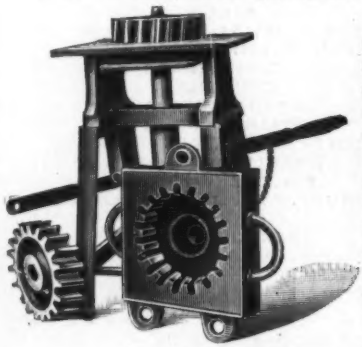

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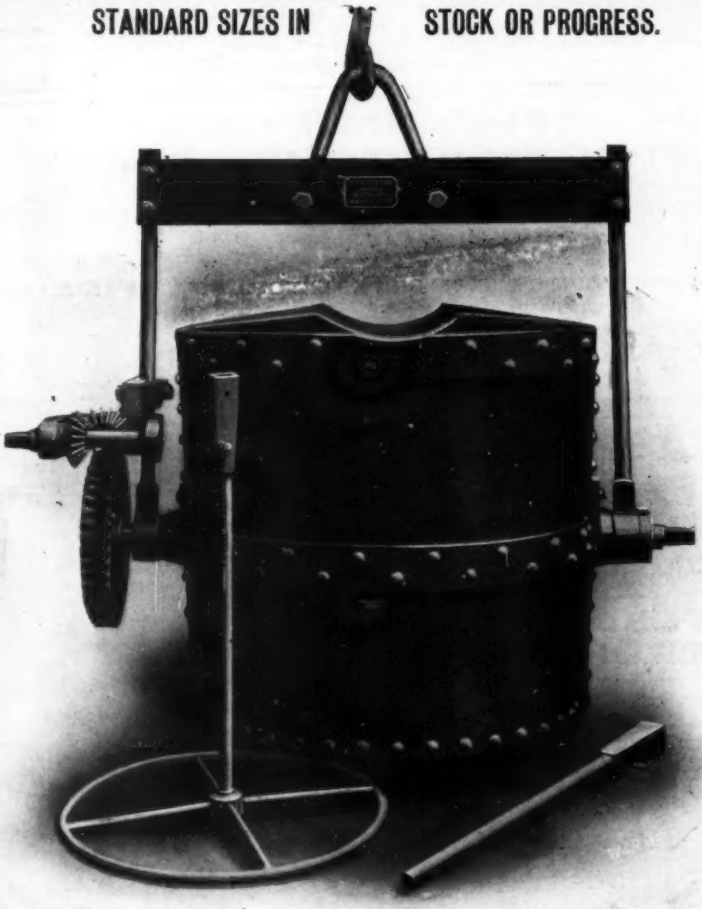

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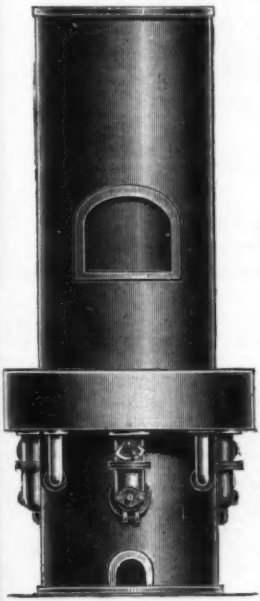

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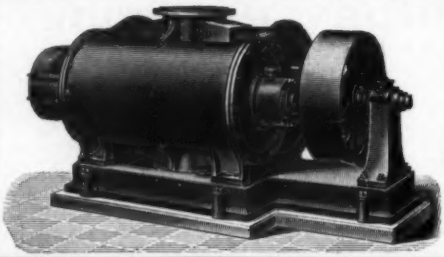

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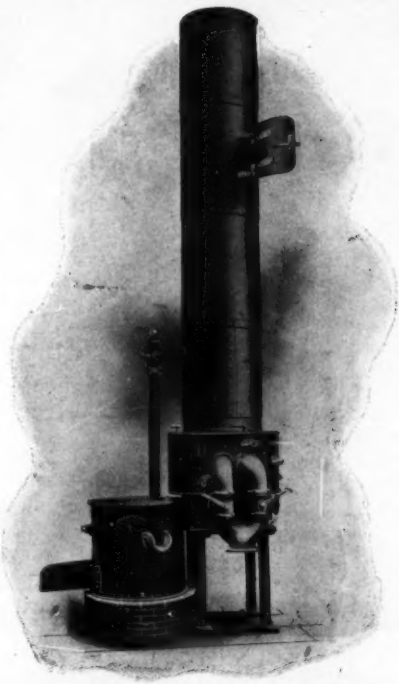

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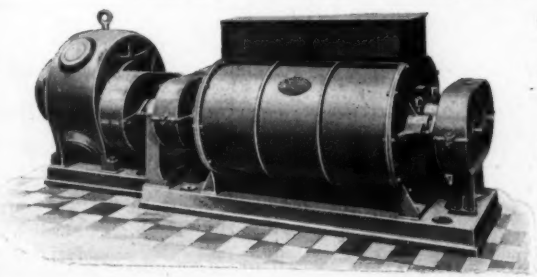

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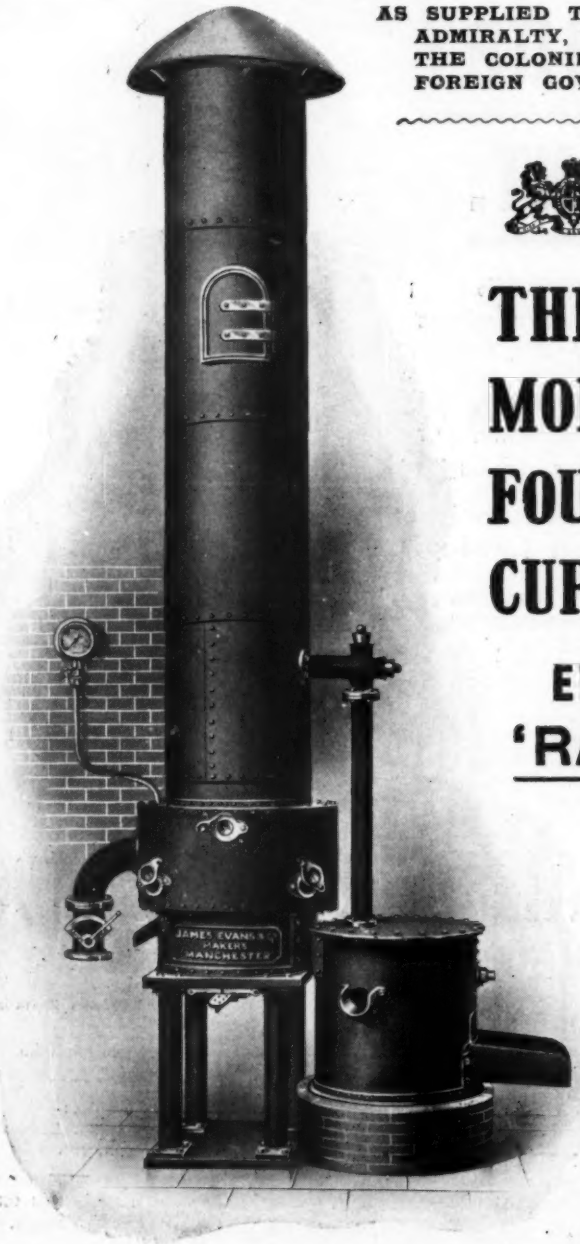

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